STATE OF OHIO
John J. Gilligan, Governor
DEPARTMENT OF NATURAL RESOURCES
William B. Nye, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Report of Investigations No. 82

PHYSICAL CHARACTERISTICS OF THE REEF AREA OF WESTERN LAKE ERIE

by

Charles E. Herdendorf
and
Lawrence L. Braidech

Columbus
1972

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by

Charles E. Herdendorf and Lawrence L. Braidech

ABSTRACT

Thirteen major reefs, which occupy about 8 square miles, and 12 major islands are present in the reef area of western Lake Erie. The reefs and islands are composed of Silurian and Devonian dolomite and limestone, allochthonous rubble, and glacial gravel, and are elongated northeast-southwest because of the structure and relative resistance of the bedrock, orientation of glacial scour, and dominant current directions.

Surface sediment samples at 1,383 stations indicated that the bottom was composed of mud (58.5 percent), sand (26.2 percent), gravel (9.4 percent), and exposed bedrock (5.9 percent). Cores at 280 stations revealed the following sequence of subsurface sediments above the bedrock: (1) glacial till clay, (2) compacted lake clay, (3) softer lake clay containing abundant plant detritus, and (4) recent mud and sand. Lag sand and gravel deposits form a thin veneer over the glacial till in the Locust Point Reef area. East and west of the Bass Islands accumulations of plant detritus represent a low-water stage (radiocarbon dates 11,300 to 4,300 years B.P.). Contemporary sedimentation studies on six reefs and in two deep areas revealed that sediment deposition rates are seasonal, with the highest rates and deposition of the largest particles in the spring. No permanent sedimentation appears to be occurring on the reefs.

Wind, bottom topography, and shoreline configuration are the major factors controlling current patterns. Surface currents are normally driven downwind while bottom currents are often opposed to the wind in the form of a compensating return flow. Repetitive measurements at 68 stations revealed average velocities of 0.28 knot for surface currents and 0.15 knot for bottom currents. Because of the shallowness, currents and associated water-level fluctuations stir the entire water column, producing nearly isothermal conditions throughout the year.

INTRODUCTION

STUDY PURPOSE AND OBJECTIVES

A three-year cooperative study by the Ohio Department of Natural Resources, Division of Geological Survey, and the U.S. Fish and Wildlife Service (Anadromous Fish Program, Project AFCS-1) was made to determine the physical characteristics of the reefs and surrounding areas in western Lake Erie. The investigation was undertaken to provide State and Federal fisheries biologists with information in support of their resource management programs, particularly as the physical makeup of the area relates to the spawning, nursery, and feeding grounds for such species as walleye *(Stizostedion vitreum vitreum),* white bass *(Roccus chrysops),* and channel catfish *(Ictalurus punctatus).* The project extended from April 1, 1967, to March 31, 1970.

The objectives of the first segment of the project (AFCS-1-1, April 1, 1967, to March 31, 1968) were to map the area topographically or bathymetrically and by sediment and bedrock type and to conduct subsurface sampling and coring to determine a chronology of ecological and geological events for this portion of the lake. The objectives of segment two (AFCS-1-2, April 1, 1968, to March 31, 1969) and segment three (AFCS-1-3, April 1, 1969, to March 31, 1970) were to complete the program of the first segment, to measure the movements and physical and chemical properties of the overlying lake water, and to relate the existing physical environment to the equilibrium of the ecosystem.

ACKNOWLEDGMENTS

The authors wish to thank Professor N. Wilson Britt of The Ohio State University for his many helpful suggestions in the preparation of this report. We wish to express our appreciation to Professor J. G. Ogden of Ohio Wesleyan University for graciously determining the age of core samples by radiocarbon dating. Dr. Ogden also analyzed the pollen in several cores. We wish to acknowledge also three senior students from Wooster College, Messrs. Joseph Benson, Geoffrey Chittick, and Douglas Lambert, for their assistance in sampling and mineral identification. We are grateful to Mr. Walter Leshniowsky, a graduate student in microbiology at The Ohio State University, for his analysis of sediment samples for pesticides.

STUDY LOCATION

The study area encompasses that part of western Lake Erie between longitude 82°37'W and 83°08'W and south from latitude 41°45'N (west of the Bass Islands) or from the international boundary (east of the Bass

Islands) to the Ohio mainland shore (fig. 1). This area is bounded roughly on the northwest by West Sister Island, on the north by North Bass Island, on the northeast by Middle Island, on the east by Kelleys Island, on the southeast by Cedar Point, on the south by the Ohio mainland, and on the southwest by Locust Point (pl. 1). The study area consists of approximately 362 square miles, including 9.5 square miles of islands.

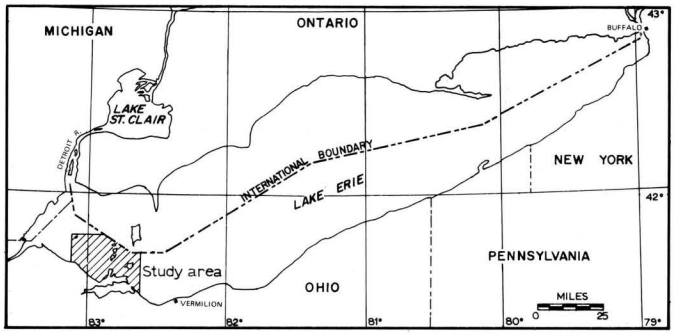


FIGURE 1.—Locality map of Lake Erie showing limits of study area.

PREVIOUS INVESTIGATIONS

Bathymetric surveys

The first detailed charts of western Lake Erie showing depths and bottom material were made by the U.S. Army Corps of Engineers in 1848 and 1877. Modern charts of the reef area are published by the Lake Survey District of the Corps of Engineers and new editions are printed every two or three years. These charts were used as bases for the detailed reef maps.

The configuration of the nearshore zone within the study area was mapped as part of a program of shore erosion control studies sponsored jointly by the State of Ohio and the U.S. Army Corps of Engineers (Beach Erosion Board, 1945, 1953, 1961). Selected sounding profiles from these studies were resurveyed as part of the present investigation.

Sedimentological studies

In a study by the Great Lakes Research Division of the University of Michigan, Ross (1950) made 71 borings and collected a few cores in the Bass Islands area. His information on sediment character and thickness and on bedrock elevations has been integrated with data from the present study.

The Ohio Department of Natural Resources, Division of Shore Erosion, made a reconnaissance survey of the bottom surface sediments of western Lake Erie in 1956. In a report on this survey, Verber (1957), using also data from Wood (1953), estimated that nearly two-thirds (58 percent) of the bottom area of western Lake Erie is composed of mud (semifluid silt- and clay-sized particles). The remaining area is sand (17 percent), mixtures of mud and sand (12 percent), mixtures of sand and gravel (7 percent), hard lacustrine and glacial till clay (3 percent), and limestone and dolomite bedrock (3 percent). Verber collected over 200 samples within the present study area; however, only a few of these samples were analyzed for grain size.

The Ohio Division of Shore Erosion also investigated the subsurface bottom sediments in the Bass Islands area from 1956 to 1960 (Hartley, 1960, 1961). Borings were made at 100 locations within the limits of the present study area by the jetting method. The borings showed a predominance of lacustrine material and rather thin till overlying bedrock. Data from these borings have also been combined with information from the present study to construct maps and cross sections of the subsurface sediments in the reef area.

The Geological Survey of Canada (Lewis, Anderson, and Berti, 1966) studied the upper layers of Lake Erie sediment by taking numerous gravity-piston cores throughout the lake. Buried shallow-pond organic sediments were found immediately north of the present study area. These have been interpreted as evidence of a former low-water stage.

Hydrologic studies

In a U.S. Weather Bureau study, Harrington (1895) made a study of the surface currents of all the Great Lakes by means of drift bottles, which were released at various points in the lake and recovered along the shoreline. In western Lake Erie Harrington deduced that only part of the Detroit River flow went south-southwestward toward Maumee Bay; the majority of the flow went eastward toward Pelee Passage. A lesser amount of river flow moved southward and eastward through South Passage. This study also indicated that central Lake Erie water flowed westward between Kelleys and Pelee Islands and then split to flow counterclockwise around Kelleys Island and clockwise around Pelee Island.

The Ohio Divisions of Shore Erosion, Geological Survey, and Wildlife have conducted several current studies in western Lake Erie in conjunction with bottom deposit surveys. Drift cards, drogues, and Ekman and Price current meters were used and water property measurements were made. The more significant investigations are summarized in the following paragraphs.

Verber (1953, 1955), using drift cards, drogues, and current meters in the island area of western Lake Erie, concluded that a rotary movement of water occurs around the islands. Measurements in Pelee Passage indicated a greater outflow into central Lake Erie than inflow into the western basin and a greater outflow at the surface than at depth. In South Passage he found the converse to be true, with a net inflow toward the western

end of the lake. He also concluded that most of the Detroit River water flowed out Pelee Passage.

From a study of long- and short-period oscillations in western Lake Erie, Verber (1960) concluded that currents associated with water-level oscillations are of two types: (1) wind currents, and (2) seiche currents, produced by the piling up of the water and its return toward equilibrium after the initial force has been overcome, reduced, or removed.

Hartley (1961) studied the bottom deposits in the island area of western Lake Erie. During this survey he made observations of the relations of waves and currents to bottom types and topography. He noted that underwater rock outcrops project above the surrounding bottom and are kept clean of sediment by rapid currents. He concluded that a large silt deposit southwest of South Bass Island was built by currents sweeping westward through South Passage and that a similar deposit northeast of Starve Island indicated easterly moving currents in the same channel.

Herdendorf (1963) studied the nearshore currents between Cedar Point and Vermilion, Ohio, with the use of a Price meter and drogues. His observations for August and September 1961 showed that westward-moving currents had the highest average velocities. He concluded that the currents in the nearshore area showed a direct response to changes in wind directions and water levels.

Hartley, Herdendorf, and Keller (1966a, b) and Herdendorf (1966a, 1969) measured conductivity, temperature, and several other water properties in dense patterns in the western basin of Lake Erie. The studies indicated that the main, midchannel, flow of the Detroit River extended far southward into the basin, both at the surface and at depth. The western portion of the river flow followed the Michigan and Ohio shores and moved northward west of the islands. The eastern part of the river flow appeared to move eastward along the Canadian shore. The study also showed that the bulk of the western-basin water moved out through Pelee Passage into the central basin of the lake. Ekman meter current measurements over the reefs in western Lake Erie were included in the report, but the data were not sufficient to establish any definite patterns. The results were, however, generally consistent with the apparent water movements as ascertained from the water-properties survey.

In a Federal Water Pollution Control Administration study, Hartley (1968) investigated the bottom currents in western Lake Erie by using seabed drifters. He found that a clockwise bottom flow exists between the Detroit River inflow and the western shore of the lake. He indicated a predominant flow out Pelee Passage, and a lesser flow out South Passage, with a possible clockwise gyre around Pelee Island and Kelleys Island. He suggested that scarcity of returns from seabed drifter releases in the midportion of the western basin may indicate sluggish bottom flow in that area.

METHODS OF STUDY

BATHYMETRIC MAPPING

A base map of the reef area was constructed from U.S. Lake Survey charts 36, 37, 39, 360, 364, 365, and 370. Water depths and the configuration of the shoreline within the reef area were obtained from these charts to construct a bathymetric map of the reef area (pl. 1). Some major alterations, particularly in the Starve Island and Gull Island Shoal areas, were made to the bathymetric map as a result of data generated by the present study. In addition, there are minor variations between U.S. Lake Survey depths and those obtained in this study, especially close to the shoreline and in other areas where depths change greatly in a short distance. Such variations can best be attributed to location accuracy of the survey boat, generalization of contours, and/or errors resulting from water-level fluctuations. All depths used on plate 1 and in this report are given in feet below Low Water Datum, which for Lake Erie is 568.6 feet above the mean water level of the Gulf of St. Lawrence at Father Point, Quebec (International Great Lakes Datum, 1955). This level is lower than the water levels which normally occur during the navigation season.

Section 1531.01 (DD) of the Ohio Revised Code defines *reef* as "an elevation of rock, either broken or in place, or gravel shown by the latest United States chart to be above the common level of the surrounding bottom of the lake, other than the rock bottom, either broken or in place, forming the base or foundation rock of an island or mainland and sloping from the shore thereof. A reef also means all elevations shown by such chart to be above the common level of such sloping base or foundation rock of an island or mainland, whether running from the shore of an island or parallel with the contour of the shore of an island or in any other way, whether formed by rock, broken or in place, or from gravel." Definition (CC) of the same section of the Ohio Revised Code describes an *island* as "a rock or land elevation above the waters of Lake Erie having an area of five or more acres above water." The Ohio Revised Code does not define the term *shoal.* However, U.S. Lake Survey charts use the terms reef and shoal for similar topographic features and they are considered synonymous in this report.

Using the legal definition as a guide, there are over 30 reefs or reef clusters shown on the charts of the study area, but only 8 of these are named officially. For convenience, the other prominent reefs are labeled with names commonly used by local fishermen (pl. 1).

Thirteen reefs and shoals were chosen for detailed mapping (Cone, Crib, Gull Island, Kelleys Island, Locust Point, Middle Harbor, Mouse Island, Niagara, Round, Scott Point, Starve Island, Toussaint, West). Depth soundings were made with a recording echo sounder (Raytheon portable fathometer, model DE-119)

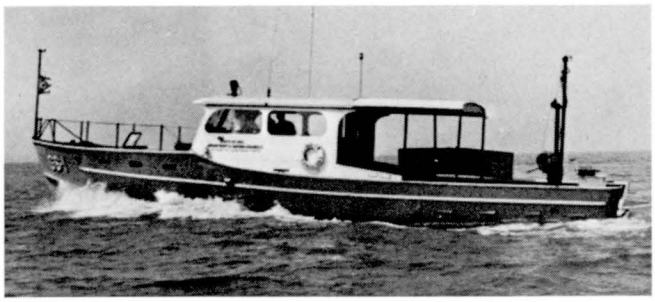


FIGURE 2.—Ohio Division of Geological Survey research boat, *GS-1*.

mounted either aboard the Division of Geological Survey's 46-foot research boat, *GS-1* (fig. 2), or, in shallow water, on a 14-foot outboard motor boat. A reconnaissance of each reef was first made to locate the shallowest water. A marker buoy was then set over this point and used as a hub for sounding profiles which were made at 15° intervals from the hub to the outer edge of the reef. Horizontal control of the marker-buoy location was obtained by sextant sightings on charted landmarks. Control of profile length was maintained by operating the vessel at a fixed rpm which had been previously calibrated for distance per unit of time. Vertical control was obtained from automatic water-level recording gages at Put-in-Bay and Sandusky.

SEDIMENT SAMPLING AND ANALYSIS

The term "surface sediment," as used in this report, refers to the top few inches of lake bottom material; "subsurface sediment" refers to deeper material. Samples of surface sediment and exposed bedrock were taken by mechanical samplers and scuba divers. Most samples were taken with a 1.5-liter-capacity LaFond-Deitz snapper-type sampler; however, a Petersen dredge, an Ekman dredge, and a hollow-tube check-valve sampler were used for special purposes, particularly for samples for chemical and biological analysis.

The surface sediment throughout the study area was sampled at half-mile intervals in a grid pattern resulting in 1,383 stations (pl. 2). Collection was made from the *GS-1*, except in shallow areas where the 14-foot outboard was used. Station accuracy is considered to be within 500 feet for nearshore stations and 1,000 feet for midlake stations. Descriptions of sediment type, color, and texture were recorded in the field. The samples were stored in 4-ounce glass jars for laboratory analysis. Accurate bottom soundings were made by use of a weighted steel cable lowered from a boat-mounted reel equipped with an automatic counter.

Bedrock samples were obtained from nine reefs and shoals (Cone, Crib, Flat Rock, Gull Island, Kelleys Island, Niagara, Starve Island, Toussaint, West) by geologists using scuba diving equipment. Most of the samples were taken from the rubble which generally flanks the reef tops; however, several rock samples were taken *in situ* for stratigraphic identification. During the dives the distinctive features of the reefs were noted, as well as the nature of the surface sediments surrounding the reefs.

The subsurface sediments in the reef area were sampled by making test borings and taking cores. Within the confines of the study area, 75 core borings were made during the present study, 71 by Ross (1950), and 134 during miscellaneous investigations by the Ohio Department of Natural Resources (pl. 2 and table C, Appendix). Borings with a "UM" prefix were made by Ross while a graduate student at the University of Michigan. The remainder of the borings were made by the Ohio Divisions of Shore Erosion and Geological Survey from aboard the *GS-1*. Borings with an "I" prefix were made as part of a study of the character and distribution of bottom sediments in the Bass Islands area (I-1 to I-72, Hartley, 1961; I-74 to I-220, unpublished). Those with a "P," "EH," or "CP" prefix were made for shore erosion control studies (unpublished). Borings with an "R" prefix and those with no prefix were made in exploration for commercial sand and gravel deposits (Hartley, 1960, 1961). Core borings with a "WR" prefix were made during the present study (WR-1 to WR-60, Herdendorf, 1968; WR-61 to WR-75 added in this report).

The hydraulic jetting method was used to make all of the borings; however, at a few locations supplemental cores were taken with a gravity-piston corer. The jetting method was developed by Wilson (1941) and modified by Pincus (1951). Briefly, the operation consists of forcing water under pressure through aluminum pipe of various diameters (2-, 1-, ½-inch). The pipe is worked up and down as the water washes out the sediment. Additional lengths of pipe are added until the desired depth of penetration is reached. The 2-inch pipe generally penetrates unconsolidated silt, clay, sand, and fine gravel, but in many cases meets refusal in compact clay, medium gravel, and glacial till, and always at the bedrock surface. The 1-inch or ½-inch pipe can be placed inside the 2-inch pipe to penetrate clay, till, and medium gravel, but these smaller tubes meet refusal in coarser material. Core samples can be taken at any desired depth with a ¾-inch hollow-tube check-valve sampler. The sampler is directed downward inside the 2-inch pipe and driven into the subsurface material by hand. Cores up to 3 feet in length were obtained by this method. Normally, one core sample was taken for every 5 feet of bottom penetration. Samples which occasionally come up the pipe between the 2-inch and smaller diameter pipe and the resistance of the bottom material to penetration also can give valuable information on the character of the sediments. The cores were measured and described in the field and then stored in glass jars or plastic wrap for laboratory analysis. In most cases borings were completed to the bedrock surface.

The process of contemporary sedimentation was studied by collecting sediment as it was being depos-

ited on six reefs and shoals (Crib, Gull Island, Kelleys Island, Starve Island, Toussaint, West) and in two deep-water locations between Kelleys Island and Gull Island Shoal. The device used for this purpose consisted of a ½-gallon wide-mouth Nalgene jar fitted with a 40-cm-long drop tube (fig. 3). The drop tube was constructed of PVC plastic tubing with an inside diameter of 54 mm. To insure stability of the collector under water, it was placed in a frame constructed of steel rods welded to a base plate. The plate, in turn, was secured to a 300-pound steel platform. On station, each collector was filled with water and the platform was fitted with a marker buoy and then lowered to the bottom. The sediment collectors were normally retrieved bimonthly and the platforms reset with fresh collection jars.

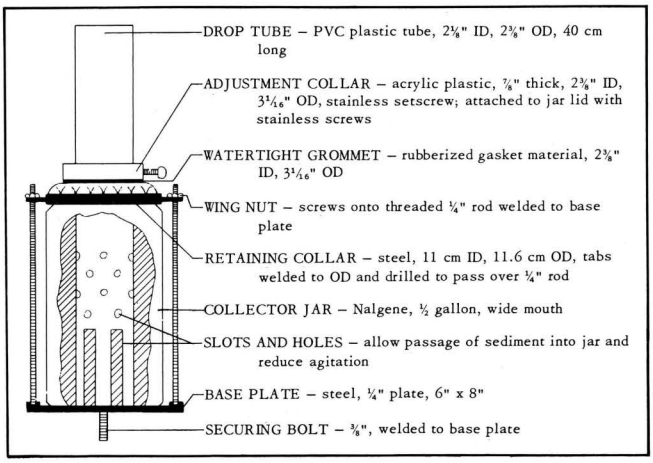


FIGURE 3.–Sediment collection device.

All surface samples and selected core and sediment collector samples were analyzed mechanically for grain size by sieve and hydrometer methods. The sieve grouping used was U.S. nos. 5, 7, 10, 14, 18, 25, 35, 45, 60, 80, 120, 170, and 230, which gives a half-phi-unit interval in grain diameter separation on the Wentworth Grade Scale (table 1). Each sample was sieved for 10 minutes on an electric shaking machine (Tyler Ro-Tap). The material retained on each sieve was weighed to the nearest one-hundredth of a gram and saved for mineral identification.

Statistical analyses were performed on the size distribution data from the samples. The percent of sediment passing through each sieve was tabulated and graphed. Three quartiles, corresponding to the 25, 50, and 75 percent lines, were determined from this percent passing curve. From this information median particle diameters in phi units (Md_ϕ) and sorting coefficients (So) were calculated. The median particle diameter of a sediment sample is that diameter size which corresponds with the 50 percent line (second quartile, Q_2) expressed in phi units. The sorting coefficient, developed by Trask (1932), is a measure of the spread of distribution and is defined statistically as the extent to which the grains spread on either side of the average ($So = \sqrt{Q_3/Q_1}$).

The following classification is useful in describing the uniformity of Lake Erie sediment, particularly in the sand and gravel ranges:

So	*Classification*
1.0-1.5	well sorted
1.5-2.5	medium sorted
>2.5	poorly sorted

Samples that consisted predominantly of mud were analyzed for grain size by the hydrometer method. This method is based on Stokes' equation for the velocity of a freely falling sphere (Rubey, 1933). The principle of this procedure is that in a dilute suspension of sediment, thoroughly dispersed and allowed to rest, all particles larger than a specific size will settle within a specific period of time and the reduction of the specific gravity of the suspension caused by this settling can be measured by a hydrometer. Calculations based on such readings can yield the weight or percent of sediment with a particular size diameter in the sample.

Samples were prepared for hydrometer analysis by hand mixing approximately 50 grams with enough water to make a thin paste. Sodium oxalate (20 ml, 0.1 normal solution) was added as a deflocculating agent and the suspension was machine mixed for 10 minutes. The mixture was then placed in a 1-liter graduated cylinder and enough water added to fill the cylinder to the 1,000-ml mark. Normally the hydrometer tests were run in a battery of 11 cylinders. Following a predetermined time schedule, each cylinder was shaken vigorously for about a minute and set to rest. Hydrometer readings were taken at 30 seconds and at 1, 2, 5, 10, 30, 60, and 120 minutes after shaking. A Taylor Instrument Company Bouyoucos-type hydrometer (model H-3863, range 0.995-1.050 specific gravity) was used for these tests. Based on an average specific gravity of 2.70, all of the sand and larger sized particles settle in 30 seconds so that the first reading indicates the combined weight of silt and clay. The 120-minute reading corresponds with the time needed for all the silt-sized particles to settle and therefore is a measure of the clay-sized material in suspension. The other readings delineate intermediate sizes of silt at approximate half-phi-unit intervals. The percentages of sand and gravel in these samples were determined by again shaking the suspension and passing it through two sieves, nos. 10 and 230.

Sediment color was determined on moist samples with the use of a Munsell soil-color chart, a system of color notation based on hue, value, and chroma (H V/C).

The percent of volatile solids, an approximate indication of the organic content of the sediment, was determined by ignition. Approximately 10 grams of each sediment sample was dried overnight at 100°C in an electric muffle furnace, allowed to cool, and then weighed. The samples were then ashed at 600°C for 60 minutes, cooled, and reweighed. The loss of weight

TABLE 1.—*Wentworth Sediment Grade Scale*[1]

Class	Grade limits			Grade name	ϕ units ($-\log_2$ diameters in mm)	U.S. sieve series
	microns (approx.)	mm	in			
GRAVEL		4096	160		-12	
		2048	80	Very large boulders	-11	
		1024	40	Large boulders	-10	
		512	20	Medium boulders	-9	
		256	10	Small boulders	-8	
		128	5	Large cobbles	-7	
		64	2.5	Small cobbles	-6	
		32	1.3	Very coarse pebbles	-5	
		16	0.6	Coarse pebbles	-4	
		8	0.3	Medium pebbles	-3	
		4	0.16	Fine pebbles	-2	5
		2	0.08	Very fine pebbles	-1	7 10
SAND	1000	1		Very coarse sand	0	14 18
	500	½		Coarse sand	+1	25 35
	250	¼		Medium sand	+2	45 60
	125	⅛		Fine sand	+3	80 120
	62	1/16		Very fine sand	+4	170 230
MUD	31	1/32		Coarse silt	+5	
	16	1/64		Medium silt	+6	
	8	1/128		Fine silt	+7	
	4	1/256		Very fine silt	+8	
	2	1/512		Coarse clay	+9	
	1	1/1024		Medium clay	+10	
	½	1/2048		Fine clay	+11	
	¼	1/4096		Very fine clay	+12	

[1]Modified from Dunbar and Rodgers (1957).

on ignition is reported as the percent volatile solids. This is not a direct measure of organic content because some volatile inorganic salts are also lost on ignition.

Mineralogical analyses were performed at Wooster College by microscopic examination and by X-ray diffraction techniques. Two samples of recently deposited sediment were submitted to the microbiology laboratory at The Ohio State University for pesticide analysis. The Cleveland laboratory of the Federal Water Pollution Control Administration performed chemical analyses and counts of benthic macroinvertebrates on 14 samples. Five cores containing plant detritus were submitted to Professor J. G. Ogden of Ohio Wesleyan University for radiocarbon dating and plant identification.

HYDROLOGIC MEASUREMENTS

Currents and several other physicochemical water properties were measured at 68 stations (pl. 2 and table 2). Surface currents were measured with drift drogues and readings were taken at 5-foot depth intervals with a Hydro Products Model 460-A current speed sensor and Model 465-A current direction sensor. The current-meter system consists of a Savonious rotor and a magnetic direction vane which transmit electrical impulses to a shipboard dial-readout unit. On station, the vessel was stabilized with a bow and two stern anchors.

Probe measurements of temperature and conductivity (specific conductance) and visual observations of water color and transparency were taken at most stations. Both temperature and specific-conductance readings were taken with an Industrial Instruments RB-3 conductivity meter fitted with a thermal sensor. The meter was connected to a weighted probe by a 100-foot cable. Measurements were normally taken at 5-foot depth intervals from surface to bottom. Water temperatures were registered in degrees Fahrenheit and specific conductance in micromhos/cm referenced to 25°C. Water transparency was determined by lowering a Secchi disc, 20 cm in diameter, until it was no longer visible. Meterological observations and wave characteristics were also recorded at each station.

Samples of surface and bottom water were taken at selected stations with a modified Kemmerer-type PVC plastic water sampler designed to collect a horizontal column of water. A complete water analysis, which was carried out at only a few stations, included the deter-

TABLE 2.—*Properties recorded at water-analysis stations*

Parameter	Measurement location	Total stations	Total visits	Total measurements
Lake currents	5-foot depth intervals, surface to bottom	68	794	3,468
Velocity (knots)				
Direction (compass°)				
Water temperature (°F)	5-foot depth intervals, surface to bottom	50	531	3,174
Specific conductance (micromhos/cm)	5-foot depth intervals, surface to bottom	36	347	2,429
Water color (visual)	Surface	47	437	438
Transparency (feet)	Surface	47	239	239
Wave characteristics	Surface	57	680	742
Direction (compass°)				
Height (feet)				
Period (seconds)				
Meteorological observations				
Wind	15 feet above water surface	68	775	840
Velocity (mph)				
Bearing (compass°)				
Air temperature (°F)	5 feet above water wurface	56	611	612
Water chemistry				
Alkalinity (ppm)	Surface and bottom	19	70	158
Chloride ion (ppm)	Surface and bottom	27	68	79
Copper (ppm)	Surface and bottom	11	222	22
Hardness (ppm)	Surface and bottom	19	51	104
Hydrogen ion (pH units)	Surface and bottom	33	101	119
Hydrogen sulfide (ppm)	Surface and bottom	2	2	4
Iron (ppm)	Surface and bottom	6	7	8
Oxygen, dissolved (ppm)	Surface and bottom	34	108	125
Silica (ppm)	Surface and bottom	3	3	4
Sulfate (ppm)	Surface and bottom	2	2	4
Turbidity (Jackson turbidity units)	Surface and bottom	33	101	119

mination of 11 chemical parameters (table 2). All of the chemical determinations were made in the field with a Hach water analysis kit. Dissolved-oxygen concentrations were obtained by the Winkler method (azide modification), using phenylarsine oxide in place of sodium thiosulfate solution. Most of the other determinations were made either colorimetrically with a Hach DR Colorimeter or by simplified titrations using premeasured Hach reagents.

In addition to measurements made from shipboard, continuous bottom-water temperatures were recorded on four reefs (Crib, Starve Island, Toussaint, West) with Ryan 15-day recording thermometers (Model D-15) operated by the Ohio Division of Wildlife. The temperature recorders were mounted on the same platforms as the sediment collectors. In addition, water and air temperatures were recorded continuously at the Ohio State Fish Hatchery in Put-in-Bay on South Bass Island by a permanently installed Taylor electrical thermometer. This instrument has a water-temperature sensor fixed 5 feet below Low Water Datum and an air-temperature sensor shaded and located 10 feet above ground level and inland about 50 feet from the dock which houses the water-temperature sensor. Only the 4:00 p.m. temperatures were used for computing the average temperatures given in this report.

RESULTS AND DISCUSSION

BATHYMETRY

General description

The bed of Lake Erie lying west of a line from Pelee Point to Cedar Point constitutes a distinct physiographic unit known as the western basin, which is separated from the deeper central part of the lake by a belt of resistant bedrock islands and reefs. The western basin has an area of 1,265 square miles, 12.8 percent of Lake Erie, but its volume, at 5.8 cubic miles, is only 5.1 percent of the volume of the entire lake because of its shallowness. The mean depth of the western basin is only 24 feet and the lake bottom, as for most of Lake Erie, is quite flat except for the sharply rising islands and reefs, which are composed of Silurian and Devonian dolomites and limestones.

In the western half of the study area the lake bottom slopes gently lakeward from the shoreline at 3 feet per mile. Between the Bass Islands and Kelleys Island this slope is 6 feet per mile and it increases to 15 feet per mile lakeward of Cedar Point. The steepest bottom slopes are found adjacent to the islands and reefs. In South Passage the bottom gradient exceeds 60 feet per mile. The maximum depths within the reef area have been found in the interisland channels. The deepest sounding, 62 feet, was made in a small depression north of Starve Island Reef. Another depression south of Gull Island Shoal is 54 feet deep. Elsewhere in the reef area, deeps do not exceed 45 feet.

The islands and reefs in the study area are arranged in three roughly north-south belts (pl. 1). The most westerly belt lies north of Locust Point and includes at least 12 reefs and West Sister Island. The middle belt extends from Catawba Island through the Bass Islands and consists of at least 14 reefs and 10 islands. The easterly belt encompasses Marblehead, Kelleys Island, and at least 7 reefs. This arrangement

of the islands appears to be controlled largely by the structure and relative resistance of the underlying bedrock, which will be discussed later in this report. The mainland shoreline of the study area is approximately 38 miles long. The westernmost 17 miles, from Turtle Creek east to the community of Rock Ledge at 4 miles east of the mouth of the Portage River, are marshy land or reclaimed marsh. The shore material is glacial till, locally covered to a shallow depth by lacustrine clay or organic marsh deposits. A low narrow sandy beach borders most of this reach. The most extensive beach in the area fronts Port Clinton, east and west of the harbor entrance. The beach marks the position of converging littoral currents from east and west, resulting in the sand accumulation (Herdendorf, 1966a).

The 6 miles of Catawba Island shoreline from Rock Ledge to West Harbor is an alternation of rock bluffs or headlands, which rise to 70 feet above lake level, and areas of glacial till. The dolomite bedrock is much more resistant to erosion than the intervening till areas, which are accordingly cut back into coves and indentations along the coast. Pebble and cobble beaches have formed locally in the coves.

From West Harbor to Lakeside, 3.5 miles, the shore is low and is bordered by sand beaches. The beaches lie on marsh deposits which accumulated in the shallow bay between Catawba Island and Marblehead Peninsula. The underlying material is glacial till and lacustrine clay. An extensive sand deposit has accumulated in the East Harbor area and low sand dunes have formed behind the beach.

The 4 miles of Marblehead Peninsula shore from Lakeside to the base of Bay Point are lined with dolomite and limestone bluffs, the tops of which are generally less than 20 feet above lake level. Sections of the shore are composed of thin-bedded rock which yields to wave attack; elsewhere the rock is massively bedded and more resistant to erosion. Glacial till commonly caps the bluffs. The narrow pebble beaches along the shore at the base of the bluffs are derived mainly from the bedrock.

The shore at the eastern end of the study area consists of a low-lying barrier beach, Cedar Point. It is 7.5 miles in length, the westernmost 4 miles separating Sandusky Bay from Lake Erie, the eastern portion dividing the adjoining swamp land from the lake. The point is 3,000 feet wide at its west end; it tapers to a width of only 300 feet in 3 miles and continues as a narrow beach, in places less than 100 feet wide, for the remainder of its length. The beach is composed of medium- to fine-grained sand which has been carried westerly by littoral currents from the eroding shores to the east. Bay Point, which extends southward from Marblehead Peninsula for two miles into Sandusky Bay, is a compound spit that is growing from sand contributed by littoral currents moving along Cedar Point and around the Sandusky harbor jetty.

The shores of all the islands are rockbound, chiefly rugged in character, with bluffs along the major portions of the island perimeters. The highest elevations are normally adjacent to the west shores, except for West Sister Island, where the bluffs are highest along the east shore. The upland area adjacent to the west shore of South Bass reaches a height of 70 feet above lake level, the highest elevation in the islands. Small beaches composed of sand, cobbles, or boulders are situated at indentations in the shoreline. The most extensive sand beach lies along the north bay of Kelleys Island.

TABLE 3.—*Tributary rivers to Lake Erie within reef area*

River	Drainage area[1] (sq mi)	Average discharge[1] (cu ft/sec)	Estimated dissolved solids[2] (tons/year)	Estimated suspended sediments[2] (tons/year)	Percent particle size of suspended sediment[3]		
					Sand	Silt	Clay
Toussaint	108	76	4,000	700	--	--	--
Portage	587	392	91,200	120,000	3	32	65
Sandusky	1,421	1,060	446,400	270,000	2	37	61

[1] Ohio Division of Water (1953)
[2] Federal Water Quality Administration (R. P. Hartley, personal communication)
[3] U.S. Geological Survey (R. F. Flint, personal communication)

Three rivers enter Lake Erie within the study area (table 3). The Toussaint River flows into the lake at Locust Point, near the west end of the area; the Portage River enters the lake at Port Clinton; and the Sandusky River empties into the lake via Sandusky Bay at the east end of the area. Three smaller streams, Turtle Creek, Rushaw Creek, and Lacarpe Creek (pl. 1), all enter Lake Erie west of Port Clinton. In addition, a number of small streams flow into Sandusky Bay. The gradients of the rivers and smaller streams are very low, normally less than 5 feet per mile in the lower reaches. These streams show little evidence of downcutting near their mouths. It is obvious from table 3 that the rivers are not prolific contributors of sand to Lake Erie and that the bulk of the sediment transported to the lake is in the clay size range.

Measurements of crustal movements by the U.S. Lake Survey (Moore, 1948) showed that the Lake Erie basin is subsiding in relation to sea level and that the

minimum subsidence is at the outlet at Buffalo. As a result, the lake is gaining in volume: water is encroaching on the land all along the shoreline. The greatest measured subsidence is at Port Clinton: 1.11 feet per century in respect to sea level and 0.57 foot in respect to the outlet. Moore calculated that the mouth of the Portage River is drowned to a depth of 6 feet, as is the upper part of Sandusky Bay. Sandusky and Put-in-Bay are subsiding at rates of 0.79 and 0.83 foot per century, respectively, in relation to sea level.

Reef bathymetry

Least depths over the Lake Erie reefs ranged from 1 foot above Low Water Datum (Gull Island Shoal) to 30 feet below this datum (Northwest Reef). Most of the reefs are conical in shape and elongated, as are many of the islands, in a northeast-southwest direction. Two factors appear to have influenced this elongation: (1) vertical joint systems in the bedrock are oriented parallel to the elongation (Hartley, 1962), and (2) the major movement of glacial ice as deduced from grooves found on the islands and mainland was from northeast to southwest.

At the 13 major reefs selected for detailed mapping, the soundings made outward from the points of least depth were plotted and then contoured at 1-foot intervals for the upper portions of the reefs. The resulting bathymetric maps are shown on plate 3. The 13 reefs cover an area of eight square miles.

The reefs consist of bedrock and associated rock rubble and gravel. The topography of the reef tops ranges from rugged surfaces caused by bedrock pinnacles and large boulders to smooth slabs of horizontally bedded rock. In places the exposed bedrock has the appearance of low stairs, with the steps dipping slightly to the east from the fringe of the reef to its crest. All of the bedrock formations that form the reefs are carbonate rocks which contain abundant solution cavities, in many cases up to 1 or 2 centimeters in diameter. The bedrock itself is commonly masked by rubble composed of material of both local and glacial origin and ranging from small pebbles to boulders up to 5 feet in diameter. On the upper portions of the reefs isolated patches of sand and gravel commonly fill vertical joint cracks and small depressions in the bedrock; at the fringes of the reefs sand and gravel or glacial till lap over the rock.

Comparative shore profiles

Nearshore areas were mapped by making 35 sounding profiles normal to the shore, at an average interval of 1.1 miles for the 38 miles of mainland shoreline. Most of the profiles extended from permanent shore points (markers established by the U.S. Army Corps of Engineers for erosion control studies) out into the lake a distance of 2,000 feet. The shore sections of the profiles were mapped by transit and the offshore soundings were made with a recording echo sounder in a fashion similar to that used to map the reefs. Sixteen comparative shore profiles (pl. 4) were selected to illustrate the typical bottom characteristics and degree of change in the nearshore depths along the mainland shoreline of the study area.

At several profile locations, changes are found in position of the shoreline with respect to shore points (pl. 7). Such changes are caused by placement at the waterline of manmade structures which influence accretion or erosion of bottom material in these areas. Most profiles were located in areas of either convergent or divergent littoral currents (see p. 24), the effects of which also contributed to changes in bottom configurations. Those profiles which exhibit relatively stable bottom conditions are in areas where the bedrock is at or near the surface. The accuracy of some of the data generated by the 1877 survey is questionable because of poor correlation with more recent profiles.

SEDIMENTOLOGY

Bedrock

The bottom surface of the lake within the reef area is composed of bedrock (5.9 percent) and unconsolidated sediments (94.1 percent). The bedrock is sedimentary in origin and was deposited as lime muds in shallow Silurian and Devonian seas, which covered the region from about 410 to 375 million years ago. A generalized section of the rocks which occur in the reef area is given in table 4. The outcrop patterns of the bedrock formations exposed in western Lake Erie are shown on figure 4. The information used to construct the geologic section and outcrop map was gathered from the works of Caley (1945), Carman (1946), Fisher (1922), Gilbert (1873), Hartley (1961), Herdendorf (1966b, 1967), Martin (1955), Mohr (1931), Mozola (1962), Newberry (1874), Sanford (1958), Sparling (1965, 1970), Stauffer (1909), Stout (1933, 1941), and Winchell (1874).

The dominant structural feature of the bedrock underlying western Lake Erie is the Findlay Arch. The nearly north-south axis of the arch lies near the western edge of the study area and plunges slightly east of north (fig. 4). This alignment of the arch gives the overlying Paleozoic bedrock a dip to the east of approximately 20-40 feet per mile. Because of the northward plunge of the arch and eastward dip from the axis the oldest formations are exposed in the southwestern part of the study area and successively younger formations crop out to the east along the flank of the arch (fig. 4). The northwest swing in the outcrop patterns in the region north of the reef area is also due to the plunge of the arch.

The land area lying south of the shoreline between Locust Point and Port Clinton is a very flat lake plain except for gentle ridges and knolls in the vicinity of

TABLE 4.—*Generalized section of rocks in reef area of western Lake Erie*

System	Group	Formation	Thickness (feet)	Description
Devonian		Delaware	35	Limestone, dark- to bluish-gray, thin-bedded; calcareous shale partings; nodular chert; exposed in vicinity of Sandusky
		Columbus	60	Limestone, light-gray to buff, moderately thin- to massive-bedded, very fossiliferous; locally changing to dolomite; exposed on Kelleys Island, Marblehead, and southwest of Sandusky
	Detroit River	Lucas	30-75	Dolomite, gray to drab, thin- to massive-bedded, relatively nonresistant; carbonaceous parting between layers; exposed in western part of Kelleys Island, on Marblehead, and southwest of Sandusky
		Amherstburg	60-80	Dolomite, drab to brown, massive-bedded, relatively nonresistant; exposed on shore near Lakeside
Silurian	Bass Islands	Raisin River	40-60	Dolomite, blue-gray to drab, thin-bedded to shaly, argillaceous; exposed on Bass Islands and on Marblehead peninsula between Lakeside and Catawba Island
		Put-in-Bay	35-60	Dolomite, gray to drab, medium-bedded, brecciated, rough-textured, crystalline; irregular knobby weathering surface; exposed on South Bass Island, Green Island, and Catawba Island
	Salina	undifferentiated	560[1]	Dolomite, dark-bluish-gray to brown, thin-bedded to shaly; calcareous shale partings in upper beds; containing gypsum and anhydrite; uppermost 15 feet exposed on South Bass Island, Catawba Island, and West Sister Island
			110[1]	Dolomite, light-drab to yellowish-brown, thin- to massive-bedded; generally dense and hard but some layers granular or vesicular; equivalent to Greenfield Formation; exposed at Rocky Ridge in Ottawa County
	Lockport	Guelph	200-450	Dolomite, white, light-gray, or bluish-gray, massive-bedded, crystalline; open and porous in texture; exposed in southwest Ottawa County

[1] Thickness from core descriptions by Sparling (1965)

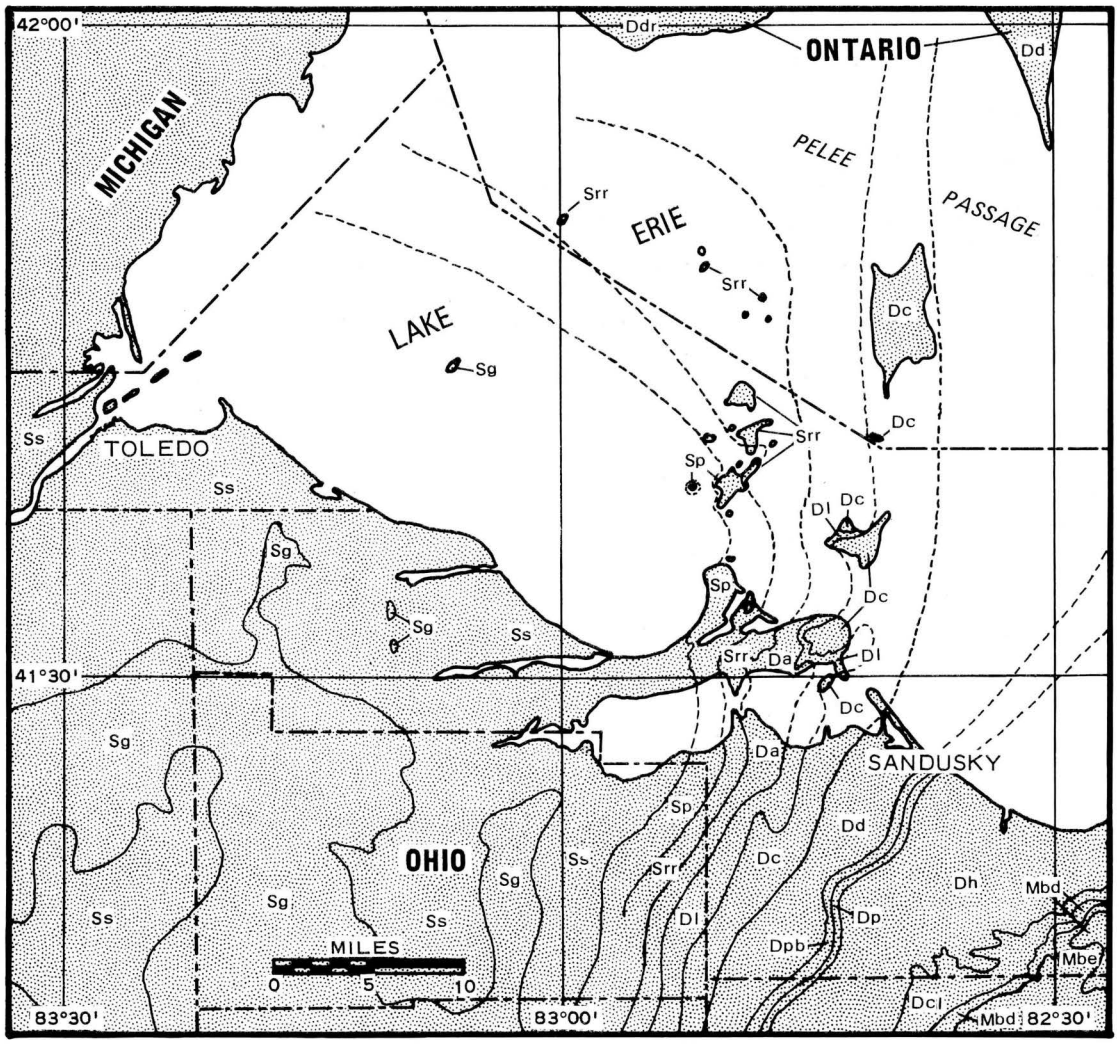
the village of Rocky Ridge in southwestern Ottawa County. The elevated areas are elongated north-south and reflect bedrock highs along the Findlay Arch; these ridges have been quarried for dolomite of the Lockport and Salina Groups. The reefs between Locust Point and West Sister Island appear to be continuations of bedrock highs near the crest of the arch.

The bedrock exposed on West Sister Island and on the reefs in the vicinity of Locust Point as far east as Niagara Reef is part of the Salina Group. This formation is highly variable in its resistance to erosion. The upper beds contain a considerable amount of shaly material and gypsum, which reduce their resistance to weathering. This factor may explain the lack of bedrock reefs between Niagara Reef and the Bass Islands.

The middle and eastern belts of bedrock islands (Catawba-Bass and Marblehead-Kelleys) are characterized by high elevations and cliffs at their western shorelines; elevations generally decrease eastward, commonly resulting in a dip slope along the eastern shorelines. The resulting topographic form is that of an asymmetrical ridge where the gentle slope agrees with the dip of resistant beds and the steeper slope is an eroding cliff, the vertical face of which is maintained partly by undercutting of less resistant rocks. The reefs in these belts, particularly Gull Island Shoal, West Reef, and Mouse Island Reef, have similar topographic shapes, with the steepest edges largely on the west sides. Because West Sister Island lies on the west flank of the arch the dip of the strata is also to the west; this has resulted in the development of a steep cliff on the east side of the island, the opposite of those formed on the more easterly islands.

Catawba and the Bass Islands are underlain by a belt of resistant dolomites of the Bass Islands Group. The Put-in-Bay Dolomite of this group is responsible for most of the rugged features of the shoreline. The less resistant upper beds of the Salina Group, exposed at the base of the cliffs, allow undermining of the rocks above, which fall away in large blocks, forming near-vertical walls (Carman, 1946).

The resistant lower beds of the Columbus Limestone are responsible for the most easterly chain of bedrock highs, which include Marblehead, Kelleys Island, Kelleys Island Shoal, and Gull Island Shoal. Between South Bass Island and Kelleys Island three formations crop out: Raisin River, Amherstburg, and Lucas Dolomites. They are all less resistant than the Put-in-



System	Group	Formation	Symbol	Lithology	Thickness (feet)
Mississippian		Berea	Mbe	Sandstone	10-50
		Bedford	Mbd	Shale	0-150
Devonian		Cleveland	Dcl	Shale	30-70
		Huron	Dh	Shale	600
		Prout	Dp	Limestone	15
		Plum Brook	Dpb	Shale	35
		Delaware	Dd	Limestone	35
		Columbus	Dc	Limestone	60
	Detroit River	Lucas	Ddr Dl	Dolomite	30-75
		Amherstburg	Da	Dolomite	60-80
Silurian		Raisin River	Srr	Dolomite	40-60
		Put-in-Bay	Sp	Dolomite	35-60
	Salina		Ss	Dolomite	670
		Guelph	Sg	Dolomite	200-450

FIGURE 4.—Geologic map of western Lake Erie.

Bay Dolomite and the Columbus Limestone and form the low channel between the ridges (Carman, 1946).

The bedrock topography of the reef area is shown on plate 5, prepared from bedrock surface elevations obtained by the jetting method at the stations shown on plate 2. The inferred surface drainage patterns of preglacial time are shown as bold dashed lines.

The lowest bedrock elevation (440.6 ft) was found between Green Island and South Bass Island. This deep, which probably resulted from erosion of the weakly resistant gypsiferous upper beds of the Salina Group, is adjacent to the highest bedrock area on the islands (Victory Woods, South Bass Island, 640 ft); this gives a maximum relief on the rock surface of approximately 200 feet. Steep bedrock surface slopes were found also on the south side of North Bass Island, in the vicinity of Rattlesnake Island, north of Starve Island Reef, and west of Gull Island Shoal.

Sediments

General composition.—The unconsolidated sediments within the reef area resulted from glacial and lacustrine deposition. During the Pleistocene Epoch the study area was covered by at least two continental ice sheets and later by a series of glacial lakes, resulting in deposition of glacial till followed by deposition of lacustrine sediments. The surface over which the glaciers moved was a stream-cut terrain underlain by Paleozoic bedrock. Glaciation moderately scoured this surface during ice advance and buried the preglacial topography under a blanket of till.

The unconsolidated materials which have been identified from the reef area include: (1) mud (semifluid silt- and clay-sized particles) rich in benthic organisms, (2) sand, (3) gravel (pebbles, cobbles, and boulders), (4) compacted lake clay, (5) plant detritus and marsh deposits (peat), (6) glacial till clay, and (7) various mixtures of these sediment types.

Surface sediment.—The distribution of the upper few inches of bottom deposits is depicted on plate 6. Bedrock comprises 5.9 percent of the bottom surface; the remainder consists of unconsolidated sediments: 58.5 percent mud, 26.2 percent sand, and 9.4 percent gravel, based on size analyses of 1,383 samples (table A, Appendix). West of the Bass Islands and northeast of a line from West Sister Island to Catawba Island, mud is present to the exclusion of nearly all other sediment types, except in the shoal areas adjacent to the islands. The line between West Sister and Catawba Islands corresponds closely to the 24-foot depth contour shown on plate 1. A wedge of mud and sandy mud reaches the shoreline between the Toussaint River and Lacarpe Creek. East of the Bass Islands most of the mud is mixed with sand except for a narrow band between South Bass and Kelleys Islands and to the northeast and southeast of Kelleys Island.

Sand and gravel deposits are concentrated in five areas: (1) north and northeast of Locust Point, (2) the bay north of Port Clinton and west of Catawba Island, (3) the west side of the Bass Islands, (4) South Passage, and (5) the Gull Island Shoal-Kelleys Island Shoal area. Extensive nearshore sand deposits are present near Port Clinton, East Harbor, and the Bay Point-Cedar Point area.

The sand and gravel north and northeast of Locust Point and in the nearshore zone from Turtle Creek to Rock Ledge are generally thin deposits which overlie glacial till. The till is a hard compact boulder clay. In fresh exposures its color is bluish gray with yellowish-brown to red zones. In composition the till consists of large rock fragments and boulders through pebbles and sand to silt and clay, with the last two predominating. Wave action readily breaks down this material and sweeps the finer sediments away for deposition in deeper water. Most of the sand and larger material are left as lag deposits which obscure the till in most places. This wave sorting probably accounts for most of the sand and gravel in this area. Some of the cobbles and boulders on the reefs are igneous and metamorphic erratics, transported and deposited by glacial ice.

Locally, the till is covered to a shallow depth with marsh deposits. Near the mouth of Turtle Creek and along Cedar Point peat deposits were found in abundance on the nearshore bottom. These deposits are fairly recent material which accumulated in marshy areas between the shoreline and barrier beaches. Shoreward migrations of the beaches have left the peat deposits in their present open-water positions.

Size distribution data for sand and gravel, median particle diameter in phi units and sorting coefficient, are presented in table B, Appendix. North and northeast of Locust Point the bulk of the sand has median diameters in the coarse and medium sand range. The median diameters decrease eastward; a large body of fine sand lies off the mouth of the Toussaint River and very fine sand off the mouth of Rushaw Creek. North of Port Clinton medium sand again predominates, although fine and very fine sand are present near the shoreline. In the vicinity of the reefs and islands, sand grades from coarse to fine in the direction of increasing water depths. Fine sand is the most common grade in the nearshore area at East Harbor and Cedar Point.

In general the surface sand deposits are well sorted in the nearshore area and more poorly sorted in the offshore areas. North of Locust Point the bulk of the sand is medium or poorly sorted. However, a large sand body of approximately 15 square miles lies east of the Toussaint River mouth and is composed of well-sorted material. Generally the sand associated with the reefs is medium to poorly sorted.

The mineral content of about 100 sediment samples collected in the vicinity of Toussaint and Crib Reefs was studied in detail. The composition of sand and gravel samples and the relative abundance of minerals in sand, mud, and till samples are listed in tables 5

and 6. The composition figures indicate that the sand and the gravel may have had different origins. The source of the sand, which is composed predominantly of quartz, appears to be the glacial till which blankets the bedrock throughout most of the area. The coarse gravel sediment, which is predominantly carbonate rock, owes its origin largely to the underlying bedrock.

TABLE 5.—*Composition of sand and gravel samples from vicinity of Toussaint and Crib Reefs*

Size of particle	Quartz and igneous rock (percent)	Metamorphic rock (percent)	Sedimentary rock	
			Carbonate rock (percent)	Other rock (percent)
Sand	62	18	15	5
Pebbles	20	46	33	1
Cobbles	7	28	64	1

The smaller gravel sizes are more equally divided between carbonate and igneous-metamorphic rocks, which indicates both bedrock and glacial till sources for this material. The muds are predominantly very fine-grained quartz, which again suggests a till source; small amounts of calcite and dolomite in the mud indicate a minor contribution from the bedrock.

Volatile-solids tests were performed on 54 samples of surface sediments (pl. 2) throughout the study area (table 7). A plot of the percent volatile material showed that muds in the northern half of the reef area had the highest organic content (7-9 percent volatile solids); an exception was a peat sample from near the mouth of Turtle Creek (13.5 percent). Sand and gravel deposits generally contained less than 2 percent volatile solids.

Chemical analyses were performed on 14 of these surface sediment samples (table 8). The analyses were made at the Cleveland laboratory of the Federal Water Pollution Control Administration, using techniques recommended by the American Public Health Association (1965). The chemical characteristics investigated were those which would have a bearing on the habitat of benthic organisms and would affect the quality of the overlying water: (1) total iron content, (2) total phosphate content, (3) organic nitrogen content, (4) ammonia nitrogen content, (5) nitrate nitrogen content, (6) chemical oxygen demand (COD), (7) hydrogen-ion concentration (pH), (8) oxidation-reduction potential (Eh), and (9) 5-day biochemical oxygen demand (BOD). The chemical characteristics of the mud samples are typical of mud from a eutrophic lake. The sample containing peat (Station 1) yielded abnormally high readings for volatile solids and organic nitrogen content, and for chemical oxygen demand. Sand and gravel samples registered the lowest values for most of the determinations made.

Benthic organisms.—Benthic macroinvertebrates were identified qualitatively and quantitatively from 13 of the stations for which sediment samples were analyzed (table 9). The samples were collected by making four drops of an Ekman dredge and passing the sediment through a U.S. no. 30 sieve. Organisms that were retained on the sieve were preserved in 40 percent formalin.

The highest numbers of organisms were found in the mud areas north of Niagara Reef (Station 407, over 8,000 organisms per square meter) and east of Round Reef (Station 556, nearly 5,700 organisms per square meter). Sand and gravel samples were conspicuously low in numbers of organisms present. The most abundant organisms in each sample were oligochaetes, worms of the family Tubificidae. Dipteran larvae, midges of the family Chironomidae, were the next most common organisms, being found in all but one sample. Other macroinvertebrates included leeches, flatworms, roundworms, clams, and snails. The composition of the benthic fauna in the mud areas is indicative of eutrophic conditions: organisms of the families Tubificidae, Chironomidae, and Sphaeriidae are all classified as pollution-tolerant forms (Beeton, 1961).

The Ohio Division of Wildlife (Baker, 1967) studied benthic organisms as part of a walleye spawning areas investigation in western Lake Erie. Collections were made on several bedrock and rubble reefs from 1960 to 1966 and the most abundant organisms identified were

TABLE 6.—*Relative abundance of minerals in sand, mud, and till in the vicinity of Toussaint and Crib Reefs*[1]

Sand samples		Mud samples[2]	Glacial till samples[2]
Light minerals (specific gravity <2.9)	Heavy minerals (specific gravity >2.9)		
Quartz	Hypersthene	Quartz	Quartz
Calcite	Augite	Clay minerals	Clay minerals
Dolomite	Rutile	illite	illite
Feldspar	Zircon	kaolinite	kaolinite
microcline	Fluorapatite	montmorillonite(?)	
orthoclase	Chlorapatite	Calcite-dolomite (minor)	
anorthoclase	Magnetite-ilmenite		
albite	Garnet		

[1] Minerals listed in order of decreasing abundance
[2] X-ray diffraction analysis

TABLE 7.—*Volatile-solids analyses of sediment samples*

Station number	Volatile solids (percent)	Type of sediment
1	13.48	Peat
10	6.01	Mud, sandy
14	2.90	Sand, silty
19	8.34	Mud
38	3.86	Till
97	8.43	Mud
102	7.86	Mud
107	7.78	Mud
124	6.37	Sand, silty
134	9.58	Mud
204	3.17	Sand, silty
208	3.25	Sand, silty
225	7.42	Mud
230	5.66	Mud
235	6.73	Mud
244	9.45	Mud
254	0.90	Sand
318	2.38	Sand, silty
350	6.55	Mud
355	7.90	Mud
360	7.21	Mud
365	0.85	Sand
372	5.25	Mud, sandy
375	7.47	Mud
380	5.46	Mud
387	6.37	Mud
397	1.91	Gravel
407	8.61	Mud
506	1.92	Sand
507	1.60	Sand
512	5.06	Mud, sandy
517	6.73	Mud
522	5.77	Mud
528	7.39	Mud
532	5.56	Mud
537	6.62	Mud
546	5.93	Mud
556	7.62	Mud
566	0.93	Sand, silty
667	8.83	Mud
672	9.05	Mud
677	9.16	Mud
682	7.05	Mud
687	8.47	Mud
691	6.75	Mud
697	4.82	Mud, sandy
705	6.77	Mud
715	7.36	Mud
725	7.12	Mud
783	6.61	Mud
805	5.36	Mud, sandy
808	7.37	Mud
814	7.25	Mud
817	3.57	Mud, sandy

isopods, amphipods, mayflies, caddisflies, and flatworms (table 10). These organisms can generally be classified as pollution sensitive. The restricted occurrence of these forms appears to be in response to the absence of fine sediments on the reefs. Apparently either they cannot tolerate being covered by silt or the silt contains lethal substances such as chlorinated pesticides.

Pfister, Dugan, and Frea (1968 and personal communication) found that floc-forming bacteria and algae may attach themselves to clay-sized suspended particles, forming a silt-sized aggregate which settles to the bottom of the lake and becomes incorporated in the sediment. They determined that these aggregates contain biological nutrients and chlorinated pesticides as well as inorganic minerals and suggested that during periods of low bottom turbulence the pesticide aggregates accumulate on the bottom. This may explain the loss of pesticide-susceptible insect larvae (of the mayfly *Hexagenia,* for instance), and the subsequent effect on dependent fish population or on other organisms in the food chain.

Subsurface sediment.—The character and thickness of the subsurface sediments within the reef area were determined from cores taken at 280 locations (pl. 2 and tables C, D, Appendix). In general, glacial till mantles the bedrock and is itself covered by compacted clay. This hard clay is in turn overlain by softer clay which contains plant detritus and which probably represents a low-water stage. The sequence of the sediments is normally completed with recent mud or sand lying at the top. In some areas the till is on or very near the surface, particularly in the reef area northeast of Locust Point, north of Gull Island Shoal, and in the vicinity of South Shoal; in others it is completely absent, as in the South Passage between Catawba and South Bass Island and adjacent to the east sides of the major islands. The generalized cross section (A-A') of bottom sediment from West Sister Island to Kelleys Island (fig. 5) illustrates the till-filled preglacial valleys on the east and west sides of South Bass Island. The till averages about 28 percent clay, 48 percent silt, and 24 percent sand and gravel (table E, Appendix).

The compacted silts and clays (fig. 5) which overlie the till in the northern part of the study area were probably deposited in deep glacial lakes (table 11). Clay averages about 36 percent (table E, Appendix) of these sediments, 10 times the percentage present in recent muds; this is indicative of deeper and quieter lakes than the one that exists now in the western basin of Lake Erie.

Extensive deposits of peat and plant detritus in a silt and clay matrix lie between the compacted clays and the recent muds. These materials have been found at 57 boring stations in the reef area at elevations ranging from 563.1 to 513.4 feet above IGLD, 1955,

TABLE 8.—*Chemical analyses of sediment samples*

Station number	Total iron (mg/g)	Total PO_4 (mg/g)	Nitrogen			COD (mg/g)	pH	Eh (mv)	5-day BOD (mg/g)
			Organic (mg/g)	NH_3 (mg/g)	NO_3 (mg/g)				
1	24.53	1.59	4.83	0.51	0.0018	191.1	7.00	274	1.3
124	23.74	1.27	0.56	0.12	0.0012	32.7	7.30	130	0.9
134	34.81	1.68	1.98	0.30	0.0024	71.0	7.20	70	2.9
244	52.58	2.17	2.20	0.38	0.0016	68.9	6.80	70	3.3
254	10.08	0.55	0.08	0.04	0.0004	4.5	7.00	376	0.2
387	35.46	1.53	1.79	0.35	0.0015	43.4	6.90	58	2.7
397	24.59	0.69	1.86	0.05	0.0006	11.8	7.20	376	0.2
407	35.62	1.80	1.65	0.30	0.0007	57.1	6.50	76	2.7
546	31.47	1.38	1.67	0.25	0.0012	39.6	6.85	94	2.1
556	36.93	1.77	2.12	0.36	0.0014	48.4	6.70	88	2.7
566	15.47	0.70	0.16	0.02	0.0004	8.8	7.50	394	0.2
705	26.95	1.60	1.96	0.33	0.0009	37.9	6.95	124	3.0
715	28.26	1.83	2.47	0.51	0.0016	42.6	6.90	124	2.9
725	31.01	1.87	2.10	0.51	0.0013	43.8	6.85	70	2.4

TABLE 9.—*Benthic macroinvertebrates*

Name	Station number												
	124	134	244	254	387	397	407	546	556	566	705	715	725
	Organisms per square meter												
Phylum Platyhelminthes													
Class Turbellaria	16												
Phylum Nematoda					97		43	86	43	11			32
Phylum Annelida													
Class Oligochaeta													
Family Tubificidae	65	3,454	2,206	183	4,455	349	7,392	1,463	5,305	610	2,647	2,109	3,185
Class Hirudinea													
Family Glossiphoniidae													
Glossiphonia complanata	16								11				
Family Erpobdellidae													
Erpobdella punctata		11	11				11						
Phylum Arthropoda													
Class Insecta													
Order Diptera													
Family Chironomidae		409	592	11	678	22	527	549	333	33	1,366	646	355
Phylum Mollusca													
Class Pelecypoda													
Family Unionidae													
Lampsilis siliquoidea							11						
Anodonta marginata		11											
Elliptio dilatatus						11							
Amblema costata										11			
Proptera alata	16												
Family Sphaeriidae		140	54		21		21						
Class Gastropoda													
Family Amnicolidae													
Bulimus tentaculata					11								

TABLE 10.—*Benthic organisms of bedrock and rubble habitats in western Lake Erie*

Organisms	Numbers/acre[1]
Phylum Arthropoda	
Class Crustacea	
Order Mysidacea	
Mysis	0.5
Order Isopoda	
Asellus	1,310.7
Order Amphipoda	
Gammarus	12,041.1
Hyalella	2,036.6
Order Decapoda	
Orconectes	78.2
Class Insecta	
Order Ephemeroptera	
Stenonema	51.0
Ephemerella	15.3
Heptagenia	6.8
Hexagenia	5.1
Order Tricoptera	
Polycentropus	239.7
Athripsoda	10.2
Order Coleoptera	
Stenelmis	3.4
Order Diptera	
Coeloanypus	8.5
Tendipes	5.1
Tipula	3.4
Phylum Platyhelminthes	
Class Turbellaria	
Dugesia	334.9
Phagocata	93.5
Cura	13.6
Phylum Annelida	
Class Oligochaeta	
Lamadilus	15.3
Tubiflex	0.3
Class Hirudinea	
Glossiphonia	15.3

[1] Information in this table was taken from Ohio Division of Wildlife data for Niagara, Crib, and Toussaint Reefs in western Lake Erie for the years 1960-1966. The collection of bottom fauna was made with a modified egg pump (Manz, 1964) towed over an area of 0.06 acre. Water depths ranged from 5.0 to 20.0 feet. Numbers of organisms per tow have been extrapolated to numbers per acre by the authors.

with a mean elevation of 533.6 feet (table 12). Core samples from this zone averaged about 12 percent volatile solids (table E, Appendix). Five of the core samples were dated by radiocarbon determination at Ohio Wesleyan University by Dr. J. G. Ogden and given a cursory examination for pollen grains (table 13).

Apparently these deposits represent a postglacial low-water stage when only shallow lakes or marshy ponds were present in the area of western Lake Erie. The plant material from this zone appears to have grown subaerially, is oxidized, and lacks species commonly associated with peat bogs. Lewis *et al.* (1966, core 1240) reported a radiocarbon date of 11,300±160 years B.P. (GSC-382) for similar deposits north of the reef area. However, radiocarbon dates ranging from approximately 4,335 to 9,440 years B.P. and oak and

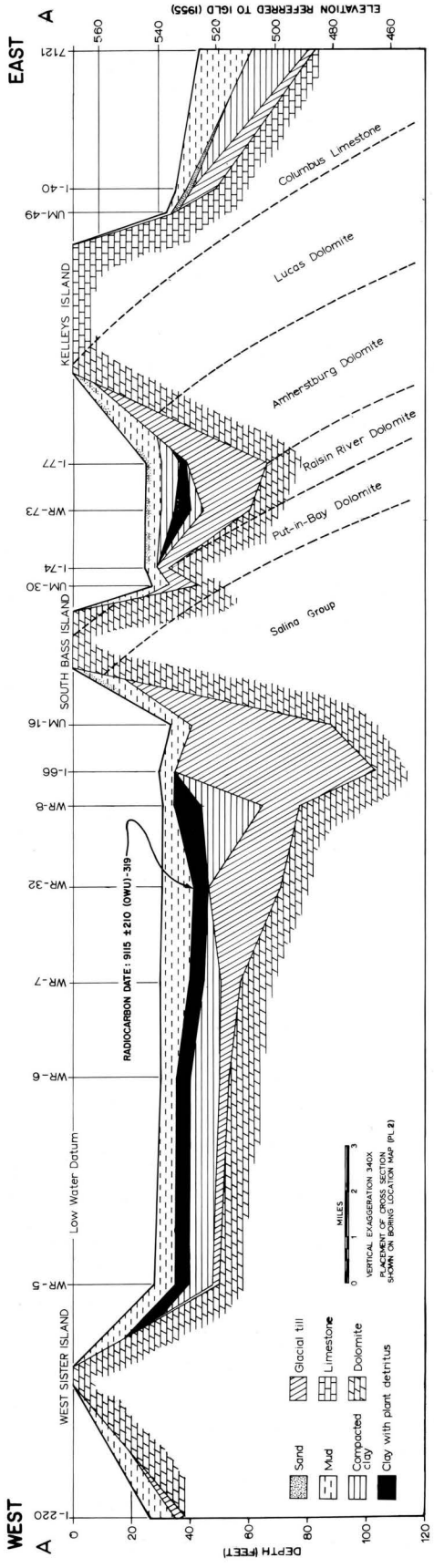


FIGURE 5.—Generalized cross section of bottom sediments in the reef area of western Lake Erie.

TABLE 11.—*Glacial lake stages of western Lake Erie*[1]

Lake stage	Age (years B.P.)[2]	Elevation (feet above sea level)	Reason for change in level	Outlet
Erie (modern)	4,300	570	Isostatic uplift to the north	Niagara River
Erie (early)	12,200	490-470	Continued ice retreat	Niagara River
Lundy		640-620	Erosion of outlet and continued ice retreat	Mohawk River or west to Lake Calumet or Lake Glenwood
Warren		680-665	Continued ice advance (Valders Drift)	Grand River, Mich.
Wayne		655	Advance of ice	Mohawk River, N. Y.
Low water stage		?	Extensive retreat of ice	Niagara River(?)
Whittlesey	13,000	735	Readvance of ice (Port Huron Moraine)	Grand River, Mich.
Low water stage		?	Extensive retreat of ice	Niagara River(?)
Arkona		710-695	Retreat of ice and erosion of outlet	Grand River, Mich.
Maumee III		780	Readvance of ice (Lake Border Moraine)	Wabash River, Ind.
Maumee II		760	Continued retreat of ice	Grand River, Mich.
Maumee I	14,000	800	Formation of first major lake stage in depression between ice and Defiance Moraine	Wabash River, Ind.

[1] Modified from Hough (1958, 1963, 1966), Forsyth (1959), and Lewis *et al.* (1966)
[2] Years before the present

pine pollen from core samples of the present study indicate a much later date for the flooding of the western basin by the waters of modern Lake Erie. When the range of all dates is considered, it is possible that the western basin stood dry, except for shallow lakes and marshes, for at least 7,000 years. The lakes appear to have been located in low areas that were occupied by preglacial streams. Probable positions, based on core samples, are shown in figure 6.

The thickness of the unconsolidated sediments ranges from zero on reef tops and adjacent to some of the islands to over 90 feet west of the Bass Islands (pl. 7). The thicker accumulations generally fill the preglacial valleys. The average thickness of sediment is approximately 26 feet. Data from a seismic survey show that the sediments increase in thickness toward the central basin (Hobson, Herdendorf, and Lewis, 1969); approximately 10 miles east of Kelleys Island and Marblehead, deposits are over 100 feet thick.

Contemporary sedimentation

Annual sedimentation in the reef area can be expressed by the formula S=D-E, where S is sedimentation, D is deposition, and E is erosion. Data from sediment collectors on six reefs indicate that a considerable amount of material was deposited during spring, summer, and fall in 1967, 1968, and 1969 (tables F-H, Appendix). However, information gathered during scuba diver surveys of these reefs shows that the sediment veneer over the bedrock is generally not more than a few millimeters thick and is commonly absent. Therefore the erosion rate is apparently nearly equal to the deposition rate. A summary of the amounts of sediment obtained during 16 collection periods on Starve Island Reef, 11 on Crib, Toussaint, and West Reefs, 10 on Kelleys Island Shoal, and 9 on Gull Island Shoal is given in tables F-H, Appendix. Table H includes also information from two collectors set in 1969 in deep water half a mile southwest of Gull Island Shoal (Deep #1) for 3 collection periods and another set in deep water 1 mile southwest of Gull Island Shoal (Deep #2) for 6 periods. During 103 days of collection in 1967, an average thickness of 1.0 mm/day of material was deposited. In 1968 175 days yielded an average of 1.4 mm/day. A 175-day study in 1969 indicated an average rate of 1.0 mm/day for the reefs and 1.4 mm/per day at the deep-water stations. The data from the deep-water collectors may indicate permanent sedimentation in those areas.

TABLE 12.—*Core samples containing peat or plant detritus*

Station number	Elevation(s) of sample
I-1	527.9, 534.9
I-5	521.2, 523.2, 528.2
I-12	518.1, 523.1, 528.1
I-14	528.3
I-16	528.3, 532.1, 532.3
I-17	528.4
I-18	523.4, 528.4
I-20	530.0, 533.0
I-21	533.1
I-23	527.2 (methane)
I-26	542.7, 543.3
I-27	538.4, 543.4
I-28	543.3
I-29	543.3
I-35	518.3, 522.3
I-36	518.3
I-38	518.3
I-41	528.3, 533.3
I-44	539.0
I-45	543.5
I-48	523.6
I-49	518.5
I-51	528.3
I-57	538.5, 553.5, 558.5
I-64	533.6
I-67	528.6, 533.6
I-72	532.1
I-77	532.1
I-80	522.1, 527.1, 532.1
WR-1	528.5
WR-2	528.2, 533.2
WR-4	533.7
WR-5	533.9
WR-6	533.6
WR-7	528.4
WR-8	528.9, 529.2, 530.9, 531.7, 534.0
WR-13	542.0
WR-19	546.4
WR-28	527.8, 531.9, 532.7
WR-31	527.5
WR-32	527.5, 532.5
WR-33	527.4, 531.4
WR-34	527.5
WR-35	527.6
WR-43	546.1, 548.6, 553.1, 558.4, 563.1
WR-51	542.2
WR-52	532.6
WR-57	543.0
WR-58	543.0, 548.0
WR-64	533.7, 539.4
WR-65	562.5
WR-70	513.4, 518.4, 523.4
WR-73	533.3, 538.1
7308	528.6
7315	531.1
R-1455	535.5
EH-8	553.1

Considerable variation was noted in the amounts of sediment collected on the individual reefs. Toussaint Reef, which is only 3.5 miles from the shoreline and is near the mouths of the Toussaint River and Turtle Creek, received the most sediment, over twice the amount that was collected on West Reef, Gull Island Shoal, or Kelleys Island Shoal. The last three reefs are located in the north and northeast parts of the study area, and are the farthest from the mainland. Starve Island Reef, located in South Passage, received the second highest amount of sediment. This is probably because of its proximity to the Portage River flow and because high velocity currents in the constricted passage are capable of carrying more and larger particles. Crib Reef, only 1.3 miles lakeward of Toussaint Reef, received considerably less sediment than Toussaint, indicating a shoreward source area for the material.

Seasonal variations in the deposition rates are also conspicuous. The spring deposition rate on Toussaint Reef was over 2 mm/day, but the summer rate was only 1 mm/day. In 1967 and 1968 the other reefs showed similar patterns, with a progressive decrease from May to August in the amount of sediment collected. A sharp rise in the rates was noted in the fall. Data from 1969 do not show as distinct a pattern but in general the trends are the same except for a high peak in early July at two of the collectors. This peak correlates with a severe storm that occurred on July 4, 1969, and which may have caused increased turbidity on the bottom of the lake.

The results of grain-size analyses of material obtained from the sediment collectors are given in table I, Appendix. In 1967, over 50 percent of the collected sediment on each reef fell between 20 and 45 microns in diameter, the medium and coarse grades of silt. The highest percentages of sand were deposited in the spring. The highest recorded sand content, 11.2 percent, was found in the spring collections at Starve Island Reef and may be explained by the high-velocity currents in South Passage. No clay-sized particles were found in the spring samples; both Starve Island Reef and Toussaint Reef yielded fairly high percentages of clay during the summer. The pattern of coarser sediment in the spring and finer material in the summer and fall was common to all the reefs. Very similar patterns were observed for 1968 and 1969 samples (table I, Appendix).

Volatile-solids determinations (table 14) on sediments collected in 1967 and 1968 indicate that contemporary sediments average about 10 percent organic matter. The highest concentration was found in sediments from West Reef (1968), the reef farthest from the mainland; the next highest from Crib Reef (1967), the shallowest reef and the one with the most noticeable growth of filamentous green algae.

Mineral identifications by X-ray diffraction were made on the sediment obtained in 1967 from collector

TABLE 13.—*Radiocarbon dates from the reef area of western Lake Erie*

Core station	Water depth (ft)	Sediment penetration (ft)	Elevation (ft)	Radiocarbon date (years B.P.)	Dated material	Pollen
I-57	7.1	23.0	538.5	6,550±134 (OWU-110)	Wood, oak *(Quercus)*	
WR-31	30.4	10.7	527.5	4,335±135 (OWU-318)	Plant detritus, subaerial plants	Abundant pine, little oak, little spruce, little birch
WR-32	30.5	10.6	527.5	9,115±210 (OWU-319)	Plant detritus, subaerial plants	Abundant pine, little oak, very little spruce
WR-33	31.2	10.0	527.4	9,440±315 (OWU-350)	Plant detritus, subaerial plants	
WR-34	31.6	9.5	527.5	5,097±175 (OWU-351)	Plant detritus, subaerial plants	Abundant oak, moderate hickory and beech, little pine

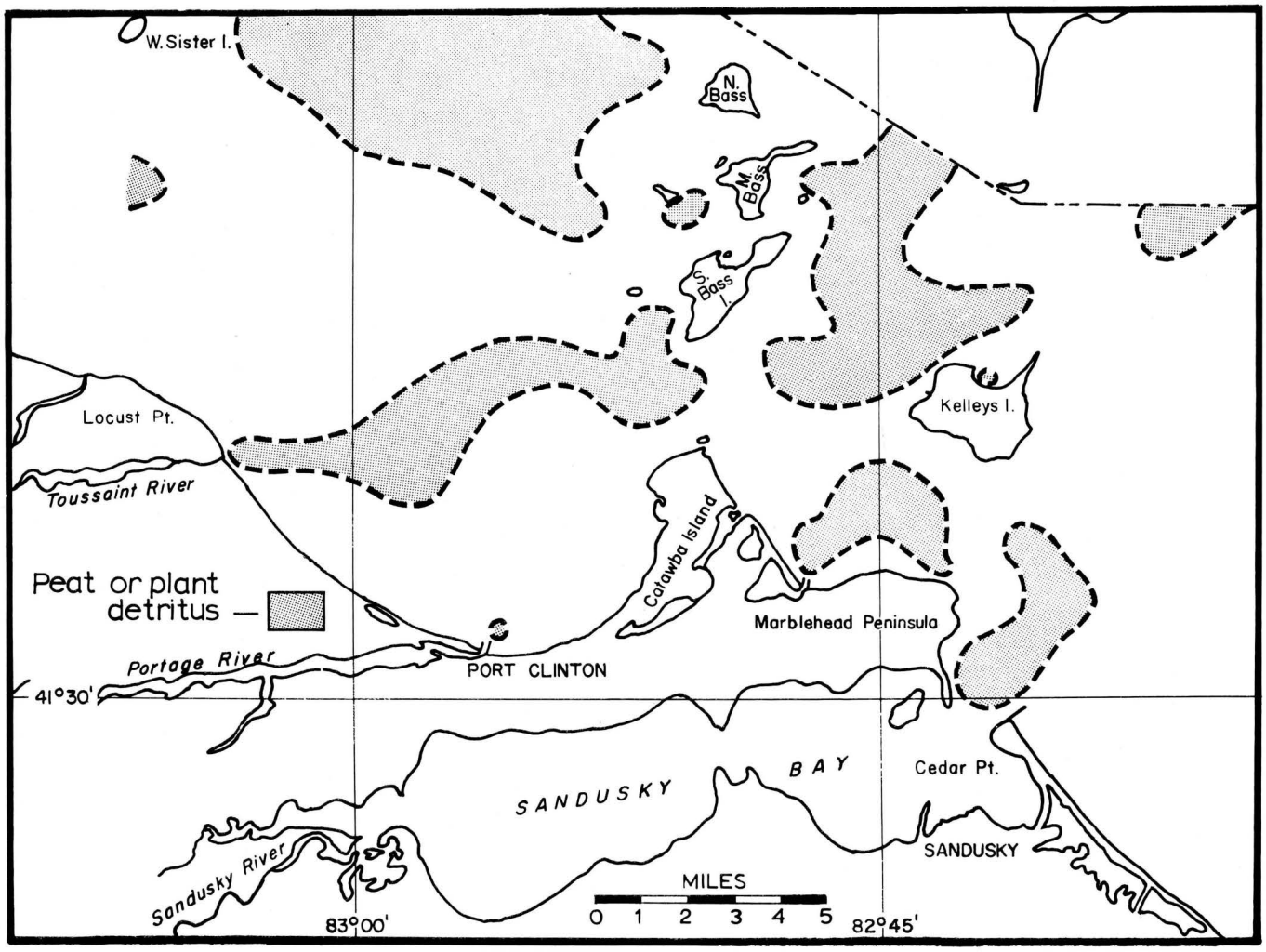


FIGURE 6.—Extent of low-stage lakes or marshes as inferred from cores.

TABLE 14.—*Volatile-solids analyses of sediment collector samples*

	Collector number	Station location	Period of collection	Percent volatile solids
1967 data	1-A	Starve Island Reef	5/13/67 - 5/24/67	9.48
	1-B		5/24/67 - 6/2/67	9.22
	1-C		6/2/67 - 6/26/67	9.89
	1-D		6/26/67 - 7/10/67	9.25
	1-E		7/10/67 - 8/22/67	9.32
	3-A	West Reef	5/13/67 - 5/24/67	10.82
	3-B		5/24/67 - 6/2/67	10.91
	3-C		6/2/67 - 6/26/67	12.55
	3-D		6/26/67 - 7/10/67	10.77
	3-E		7/10/67 - 8/22/67	10.41
	5-A	Crib Reef	5/11/67 - 5/24/67	8.89
	5-B		5/24/67 - 6/5/67	8.99
	5-C		6/5/67 - 6/26/67	10.49
	5-D		6/26/67 - 7/10/67	13.24
	5-E		7/10/67 - 8/22/67	11.61
	8-A	Toussaint Reef	5/11/67 - 5/24/67	9.21
	8-B		5/24/67 - 6/5/67	8.61
	8-C		6/5/67 - 6/26/67	9.68
	8-D		6/26/67 - 7/10/67	9.92
	8-E		7/10/67 - 8/22/67	10.25
1968 data	2-A	Starve Island Reef	4/26/68 - 6/4/68	8.89
	2-B		6/4/68 - 6/19/68	8.98
	2-C		6/19/68 - 7/26/68	9.27
	2-D		7/26/68 - 8/19/68	10.21
	2-E		8/19/68 - 9/26/68	9.65
	2-F		9/26/68 - 10/17/68	9.30
	4-A	West Reef	4/26/68 - 6/5/68	9.66
	3,4-B		6/5/68 - 6/19/68	10.48
	4-C		6/19/68 - 7/22/68	11.60
	3,4-D		7/22/68 - 8/8/68	11.01
	4-E		8/8/68 - 9/26/68	14.05
	4-F		9/26/68 - 10/18/68	10.01
	6-A	Crib Reef	4/26/68 - 6/5/68	9.30
	5,6-B		6/5/68 - 6/20/68	8.95
	6-C		6/20/68 - 7/26/68	10.80
	6-D		7/26/68 - 8/21/68	11.76
	6-E		8/21/68 - 9/26/68	10.96
	5-F		9/26/68 - 10/16/68	10.41
	8-A	Toussaint Reef	4/26/68 - 6/5/68	8.43
	7,8-B		6/5/68 - 6/20/68	9.57
	8-C		6/20/68 - 7/26/68	9.94
	8-D		7/26/68 - 8/21/68	11.93
	8-E		8/21/68 - 9/26/68	10.56
	8-F		9/26/68 - 10/16/68	10.09

8-A, Toussaint Reef. Quartz was found to be the dominant mineral, with minor amounts of calcite and dolomite. The clay minerals illite and kaolinite were also present in small amounts. A very weak peak was observed for montmorillonite, too weak to confirm its presence.

Contemporary sediment retrieved from two collectors was analyzed for pesticides. The sediment was collected in April 1969 on Starve Island Reef (table H, collector 2-B) and in July 1969 at Gull Island Deep #2 (collector 8-E). The sediment and the overlying water were analyzed on an electron capture detector (GLC) and on a microcoulometer. The quantities of the pesticides detected were not precisely determined; they probably lie in the nanogram range but possibly are greater. The qualitative results of the tests are:

Samples analyzed		Pesticides present	
		GLC	Microcoulometer
Gull Island Deep #2	Water	Dieldrin Lindane	Dieldrin
	Sediment	Dieldrin Endrin Lindane	Endrin
Starve Island Reef	Water	Heptachlor	(negative test)
	Sediment	Aldrin Dieldrin Heptachlor Lindane	Aldrin Dieldrin

The presence of these chlorinated hydrocarbons, particularly aldrin, which has a short half-life, in recently deposited sediments strengthens the contention of Pfister *et al.* (1968) that insecticidal effects on bottom insects and other susceptible fauna may be in part the result of pesticides in the bottom sediments.

HYDROLOGY

General statement

The principal hydrologic factors which are considered in this study are (1) water-level fluctuations, (2) circulation patterns developed in the lake under various wind conditions, (3) seasonal temperature changes in the lake, and (4) general status of several other physicochemical properties of the lake water within the reef area.

Water-level fluctuations

The highest and lowest average monthly levels on Lake Erie generally occur in June and February, respectively. The seasonal variation typically ranges from 1 to 2 feet. The mean level for the period of record (1860-1969) is 570.4 feet, as measured by the U.S. Lake Survey, Army Corps of Engineers. The highest average monthly level recorded was 572.8 feet, reached in May 1952, and the lowest average monthly level recorded was 567.5 feet in February 1936 (fig. 7). This represents a change in the lake's volume of approximately 9 percent. In 1969 Lake Erie reached record high levels for the months of July (572.5 feet) and August (572.3 feet).

Water-level changes on Lake Erie are of two principal types, long-period and short-period oscillations. Long-period fluctuations are related to volumetric changes of the lake, caused principally by variation in precipitation, evaporation, and runoff, and may be seasonal or may occur over a period of several years. Short-period fluctuations are due to a tilting of the lake surface by the wind or possibly by atmospheric pressure differentials over the lake surface. Wind tides, seiches, surges, and harbor resonance, which have periods from a few seconds to several days, are examples of short-term oscillations. Sun and lunar tides are negligible, resulting in a maximum fluctuation of about 0.11 foot (Verber, 1960).

Water levels have a greater range in fluctuation at the ends of the lake, at Toledo and Buffalo, than at the center of the lake in the vicinity of a nonoscillating nodal zone (see p. 24). High water levels coupled with northeast storms have produced a maximum fluctuation of 7.1 feet above Low Water Datum at Toledo. Conversely, low levels and southwest winds have lowered the level to 7.5 feet below datum, a range of 14.6 feet. Under the influence of wind, currents tend to bank up water on the windward shore. This forced movement of the lake surface is known as wind tide and the amount of rise produced is the wind setup. The resulting free oscillation of the lake surface caused by the inequality of water level is called a seiche. The feature that

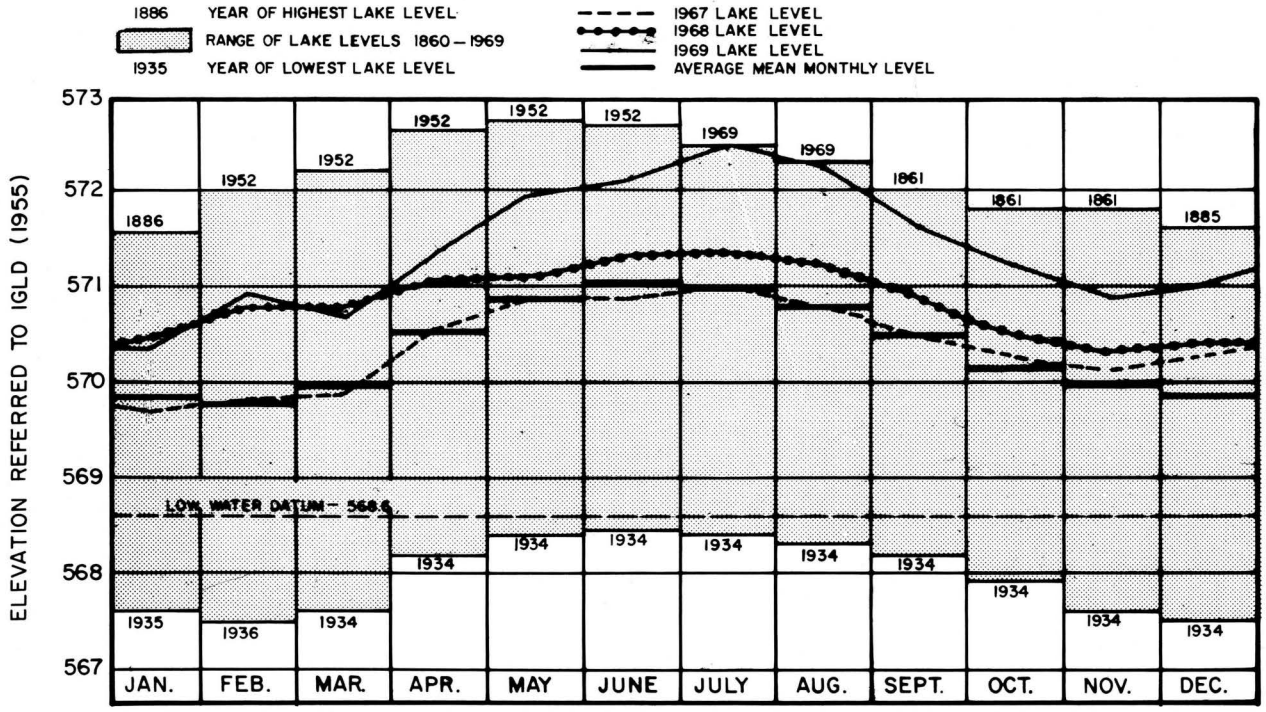


FIGURE 7.—Mean monthly lake levels during study period (1967-1969).

distinguishes the wind tide from the seiche is the extreme variation in the time period of the wind tide. Wind tide may pile up water for only a few hours or for as long as 48 hours during severe storms (Verber, 1960). Seiches have a more regular period, governed by the length of the oscillation, which is controlled by morphology of the basin, wind direction, and existing lake level.

The major seiches on Lake Erie are essentially parallel to the longitudinal axis of the lake. Seiches along this axis have a period of approximately 12 to 14 hours. Figure 8 shows the frequency of occurrence for seiche periods for three years as recorded at the State of Ohio water-level gage on South Bass Island. It can be seen that longitudinal seiches were in operation about 44 percent of the year. Surface winds from the southwest and northeast are likely to produce such seiches along the longitudinal axis of the lake. U.S. Weather Bureau wind records for Sandusky, Ohio (fig. 9), are in agreement with frequency of seiche periods; surface winds from the southwest and northeast occur about 150 days (42 percent) per year. Seiches with periods shorter than 12 hours are generally transverse or oblique to the major axis. Wind tide can combine with seiche activity to shorten the oscillation period or to prolong it several times the normal period.

A detailed study of water-level fluctuations made from May 1 to July 11, 1968, in the vicinity of South Bass Island showed that during the nearly 1,700-hour study 169 seiches were recorded with a period greater than one hour. The seiches ranged from harbor resonance, with a period of a few minutes, to wind-tide-prolonged seiches, with a period of 22 hours. The average period was 10 hours. Longitudinal seiches were in operation during approximately 40 percent of the study period and were by far the most common (fig. 10). Up-or-down water-level changes appear to be dependent on the direction of current flow. In general, a dominant flow toward the west will cause a rise in the water level and an eastward flow will cause the level to fall.

Currents

Circulation patterns.—Lake currents were measured at 68 stations (pl. 2) at 5-foot-depth intervals from surface to bottom. The surface and bottom velocities and directions at each station were averaged in relation to the eight major wind directions for surface and bottom currents (table J, Appendix). The velocities at each 5-foot depth interval were also averaged without regard for wind direction (table K, Appendix).

The surface and bottom current data from table J

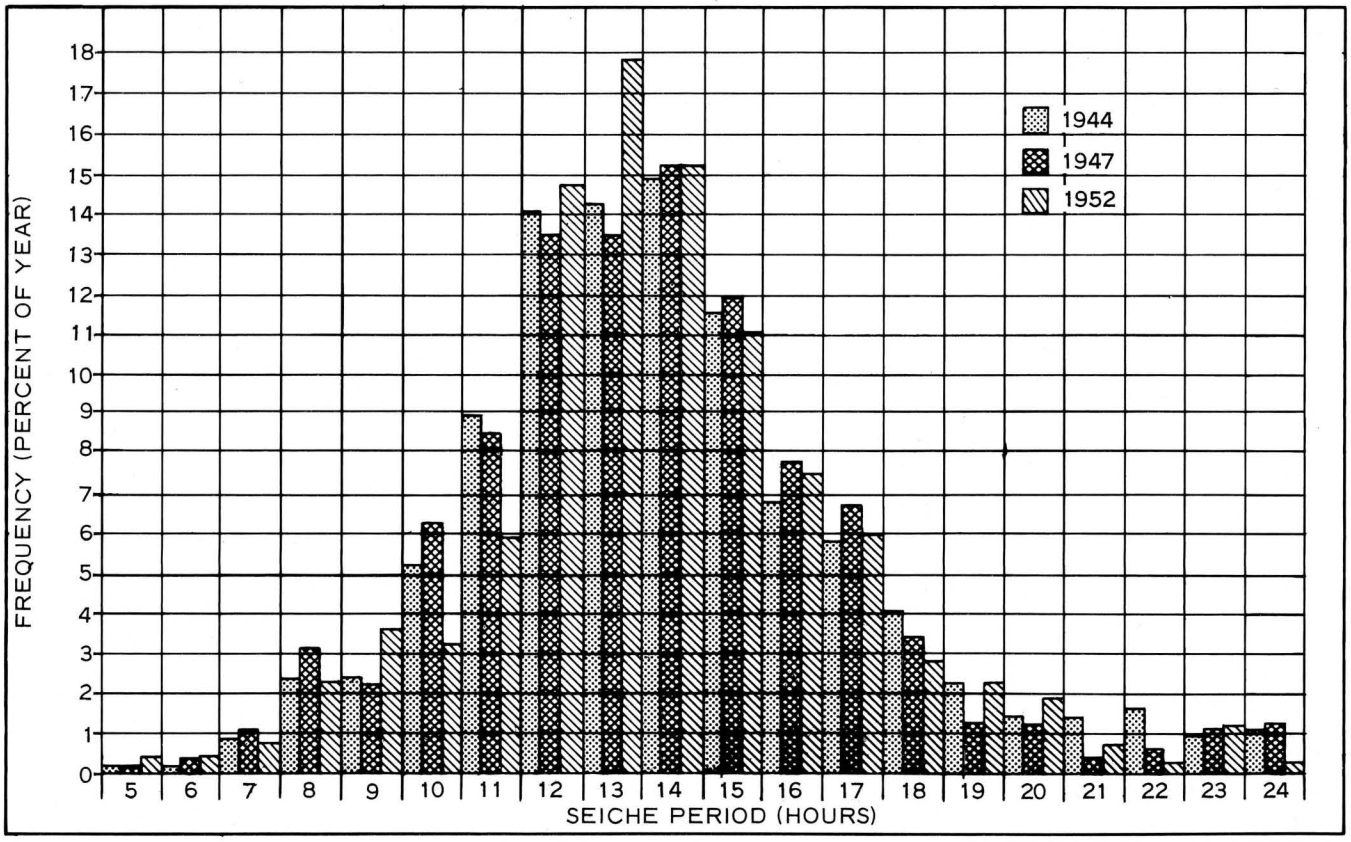


FIGURE 8.—Annual frequency of occurrence of seiche periods at Put-in-Bay, Ohio (1944, 1947, and 1952).

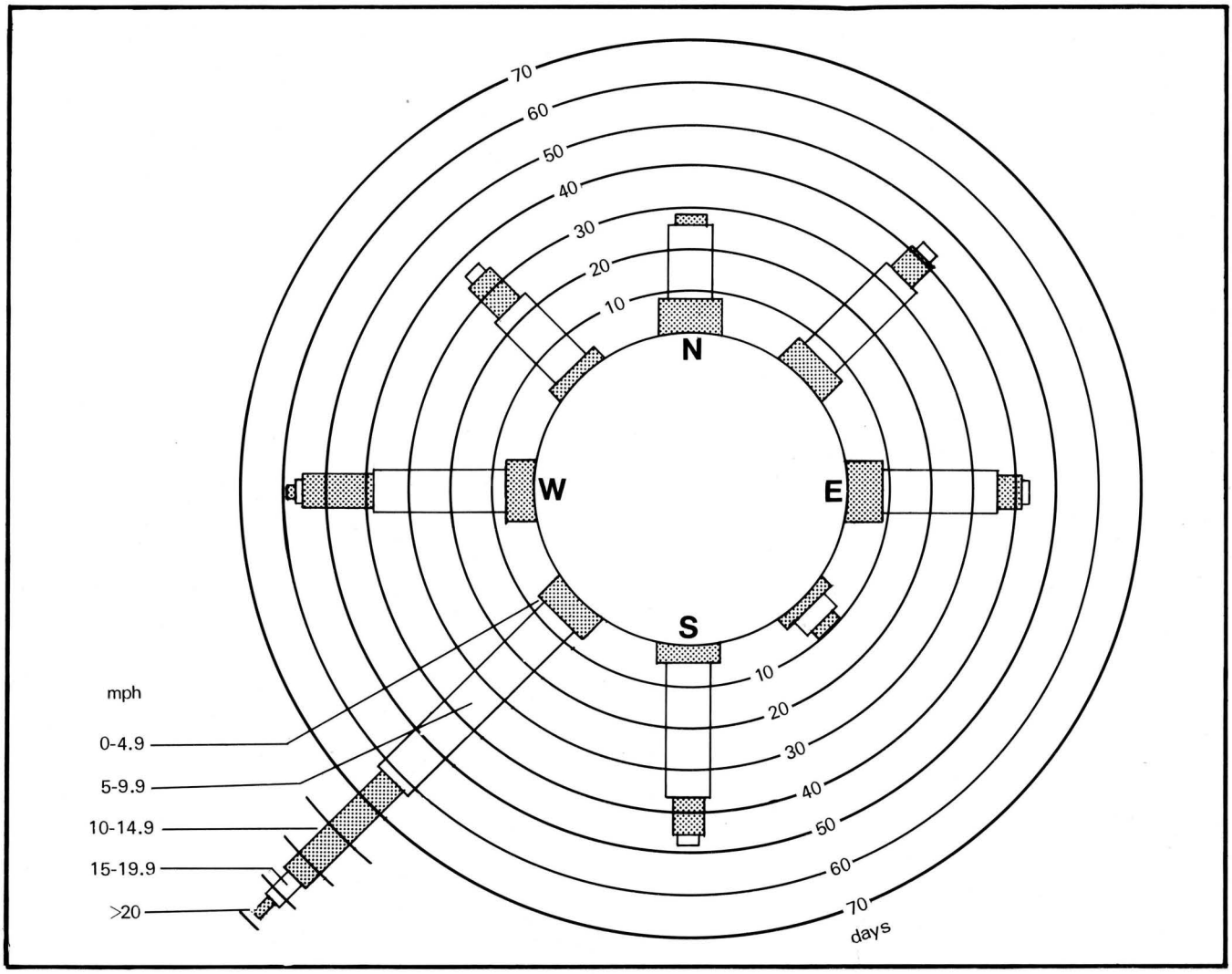


FIGURE 9.—Average annual winds at Sandusky, Ohio, for ten years (1948-1957).

were plotted on blank maps of the reef area for the eight major wind directions. From these plots, generalized circulation patterns were drawn (fig. 11). The most striking feature is that for winds from every direction the surface currents are normally driven downwind while subsurface currents are often opposed to the wind as compensating return flow. Wind direction, bottom topography, and shoreline configuration appear to be the major factors controlling the various current patterns.

The average recorded velocities for surface and bottom currents were 0.28 knot and 0.15 knot, respectively. These velocities are not capable of eroding bottom material, but are able to transport the lower sand grades, silt, and clay, once they have been placed in suspension (fig. 12). It is likely that velocities in these ranges are sufficient to limit the deposition of clay-sized particles within the reef area. The highest velocities were recorded in restricted areas such as interisland channels and bay mouths and in the vicinity of the reefs. Currents in excess of 0.5 knot were noted at 24 stations: 2, 3, 4, 5, 6, 7, 8, 15, 24, 28, 29, 36, 37, 39, 41, 43, 44, 46, 47, 52, 53, 59, 60, and 61 (pl. 2). Velocities above 1.0 knot were measured at only one station: 61.

Alongshore currents.—Alongshore or littoral currents are the most important agents of erosion, transportation, and deposition of sediment along the shoreline. They are normally generated by waves in the nearshore area. As waves approach the shoreline under the influence of wind, the water level rises slightly near the shore and the excess water that is pushed shoreward escapes as alongshore current. These currents are generally set up parallel to the shoreline, are controlled by the nearshore topography, and move in a direction away from the wind. When wind and wave

conditions are favorable, the resulting alongshore currents may attain velocities capable of eroding and moving particles as large as sand and gravel (fig. 12) along the bottom.

Littoral drift is the net alongshore movement of sediment over a fairly long period of time. The major cause of littoral drift is wave action and the resulting alongshore currents. A study of the long-term movement of sediment along the shore is therefore a useful method of determining the predominant nearshore current movements.

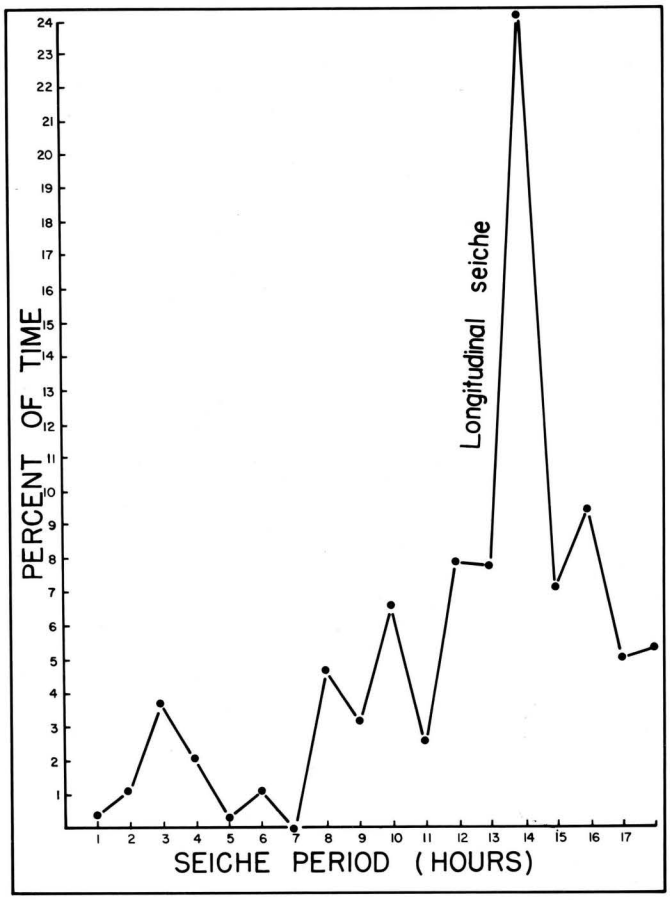


FIGURE 10.—Frequency of occurrence of seiche periods at Put-in-Bay, Ohio (spring, 1968).

The combination of direction, velocity, duration, and open-water fetch of the wind determines the strength of the waves and the resulting currents. When these factors are balanced for two opposing directions, a neutral or nodal zone occurs. Neutral zones may be classified as areas of either divergence or convergence. Those of divergence are areas where littoral currents flow away from each other and erosion generally occurs; those of convergence are areas where drifts of opposing directions meet, producing accretion or sedimentation.

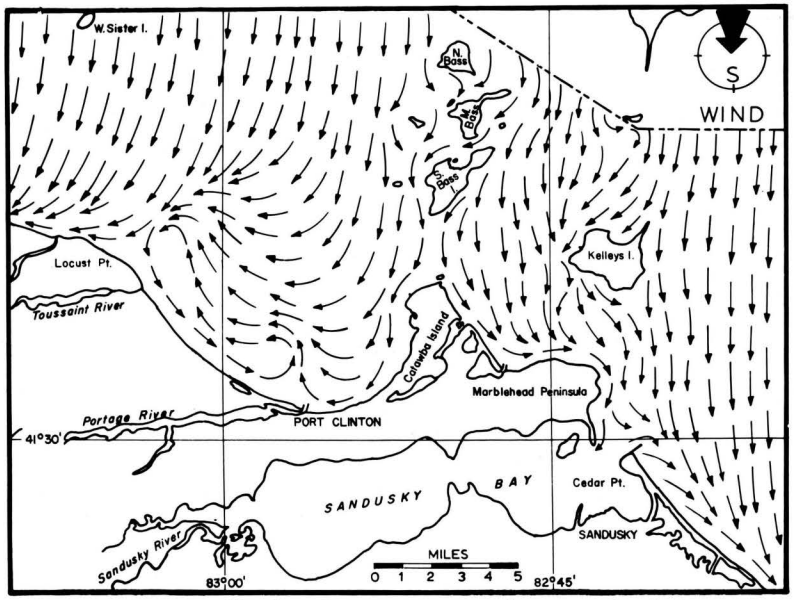
The shore in the vicinity of Locust Point is within a nodal zone of diverging currents and shows no appreciable littoral drift in either direction. The 15-mile stretch of shoreline west of Locust Point to Maumee Bay is characterized by a weak northwestward drift due to the long easterly fetch and the corresponding shorter fetch for westerly winds. From Locust Point to Port Clinton the drift is southeastward and relatively weak.

The direction of littoral drift between the Portage River and Scott Point is to the southwest toward a convergence area at Port Clinton. Currents are weak and sand is practically absent in the littoral zone because of the dolomite bluffs along this reach of shore. Southeast of Scott Point a barrier beach has been built in the area of West, Middle, and East Harbors by the convergence of opposing littoral drifts originating at Scott Point and the northeast tip of Marblehead Peninsula.

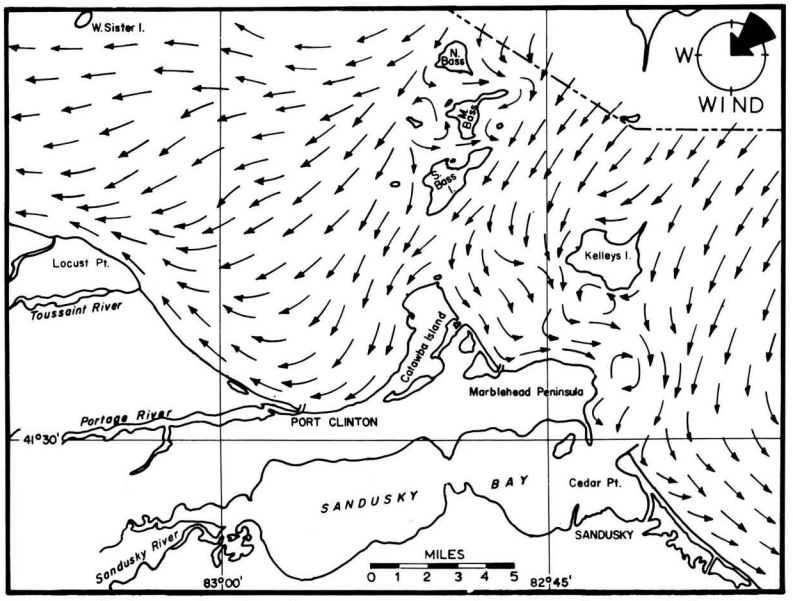
The mouth of Sandusky Bay is another area of convergence. A weak drift carries some sand southward from Marblehead to Bay Point, which is accreting at a rate of several feet per year. However, most of the sand appears to be contributed by littoral currents moving northwest along Cedar Point, around the harbor jetty. Current measurements made in this vicinity and eastward in the nearshore zone off Cedar Point yielded velocities as high as 0.75 knot (Station 41). The average velocity of surface currents was 0.40 knot; 5 feet below the surface, 0.26 knot; 10 feet, 0.23 knot. On days with only a moderate wind from the east-northeast, bottom currents with velocities up to 0.47 knot were recorded. Currents with velocities of this magnitude are capable of eroding and transporting sand from 0.06 to 1.0 mm in diameter (fig. 12). Velocities as low as 0.36 knot, which were common, are effective in the transportation of sand in the fine to medium size ranges. During storms the velocities are undoubtedly much higher and the currents are able to set larger particles in motion and carry them farther. Westerly currents dominated along Cedar Point and showed the highest average velocities.

Thermal conditions

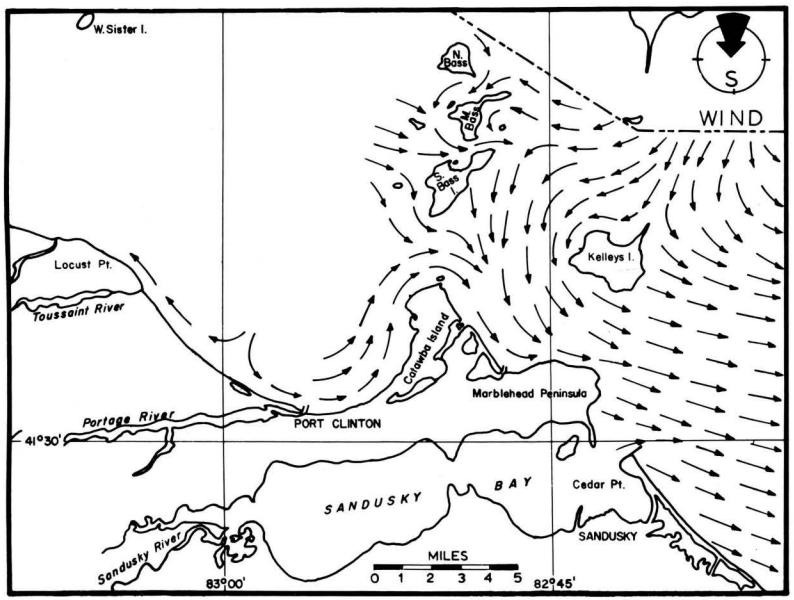
Water temperatures of western Lake Erie undergo wide seasonal fluctuations, ranging from 33°F in the winter to about 75°F in late summer. The western basin frequently freezes across, but only rarely do the other basins freeze from shore to shore. The ice cover breaks up in March or April and gradual warming continues through the spring. Rogers (1965) describes the warming process in terms of a thermal bar: when the nearshore water has heated to a temperature of maximum density (39.2°F), a vertical thermal bar of water near that temperature forms a boundary between the midlake waters, with temperatures less than 39.2°F, and the continually warming inshore waters. During a



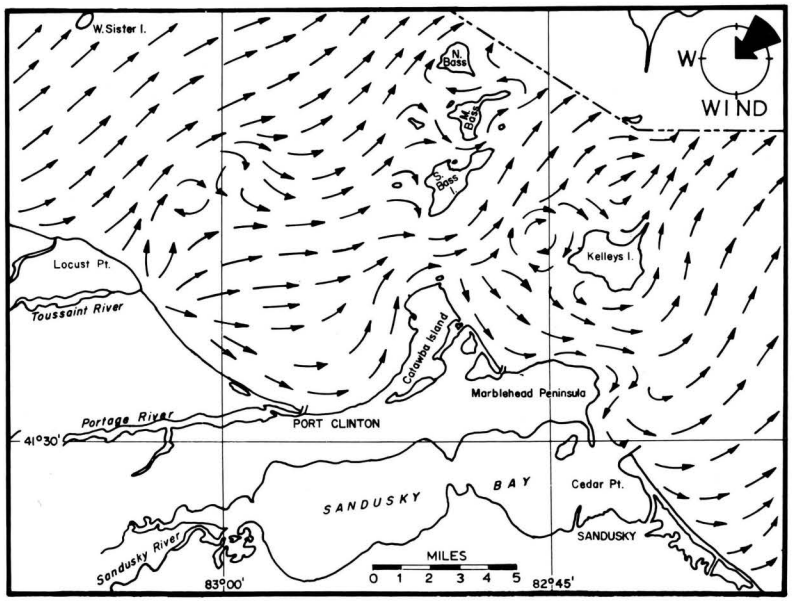
A, Generalized surface currents, moderate north wind



C, Generalized surface currents, moderate northeast wind

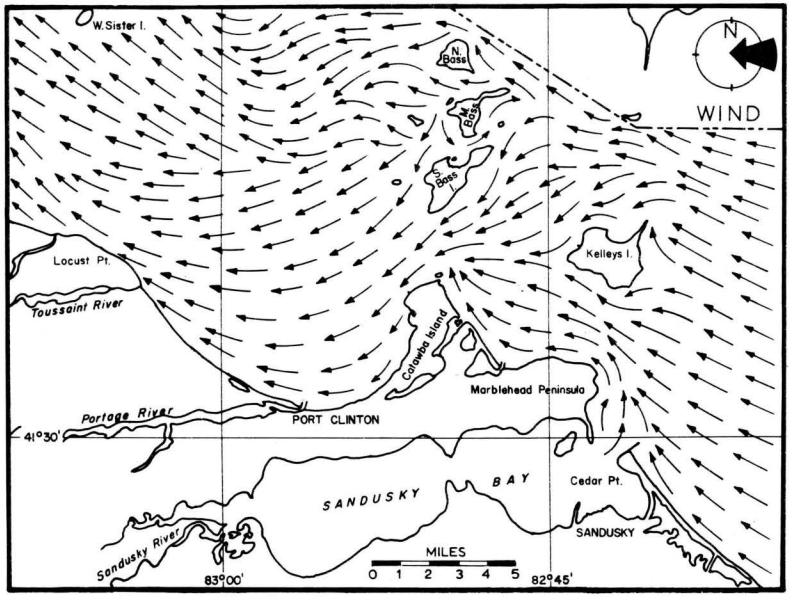


B, Generalized bottom currents, moderate north wind

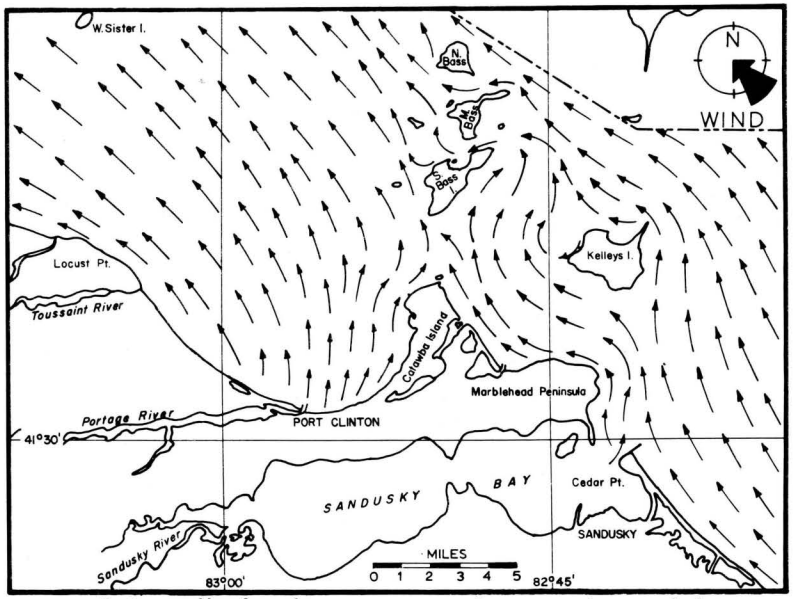


D, Generalized bottom currents, moderate northeast wind

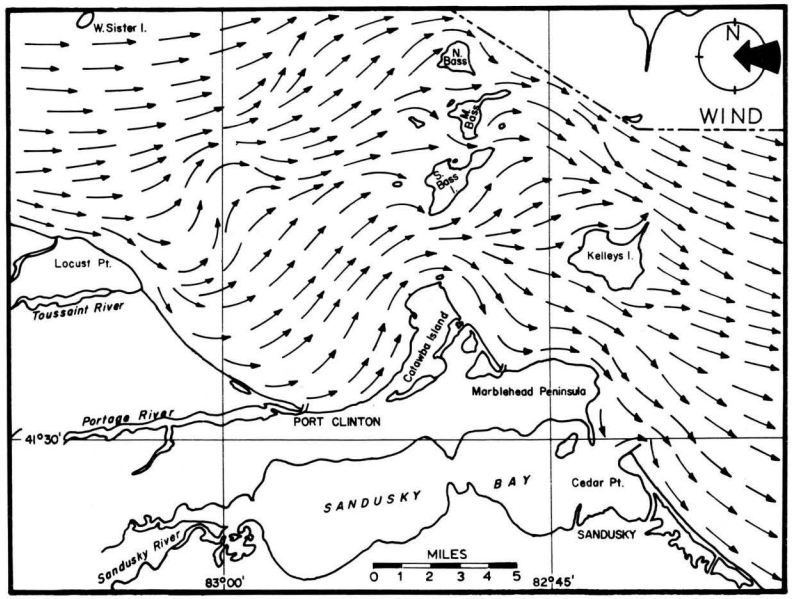
FIGURE 11.–Generalized current diagrams for western basin of Lake Erie.



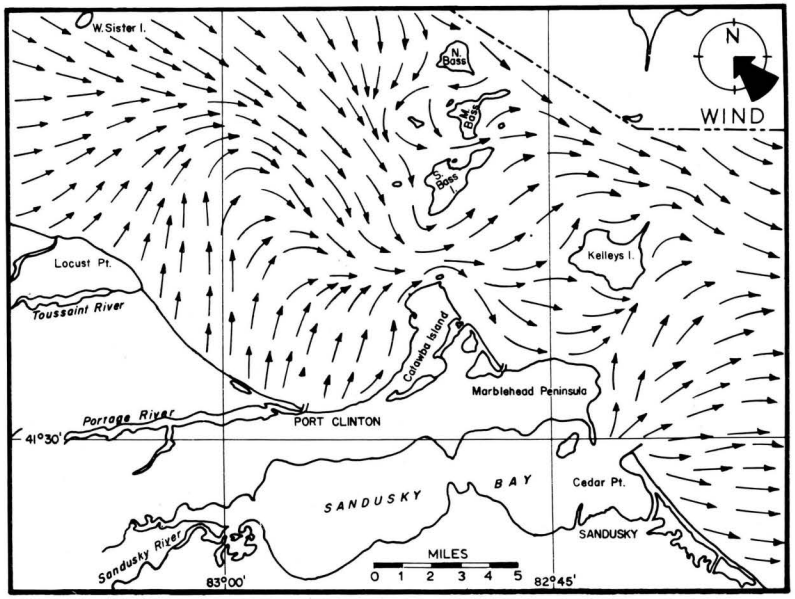
E, Generalized surface currents, moderate east wind



G, Generalized surface currents, moderate southeast wind

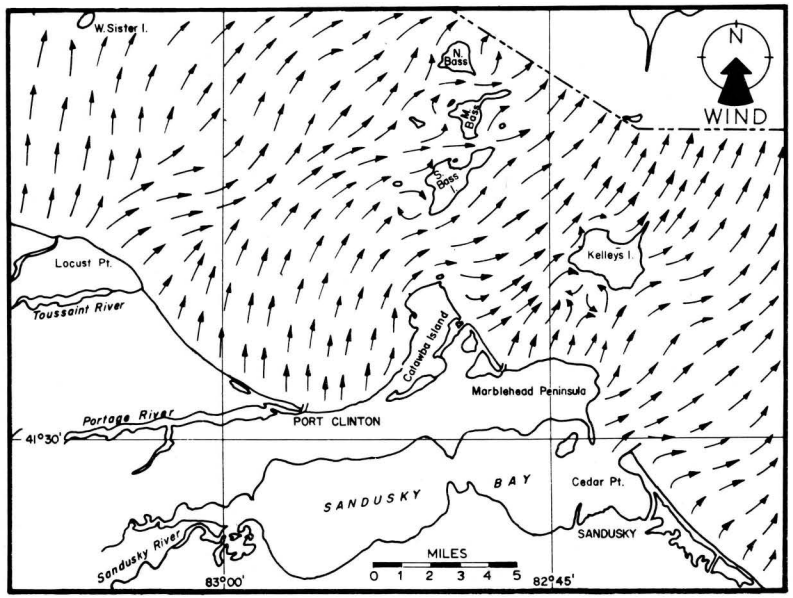


F, Generalized bottom currents, moderate east wind

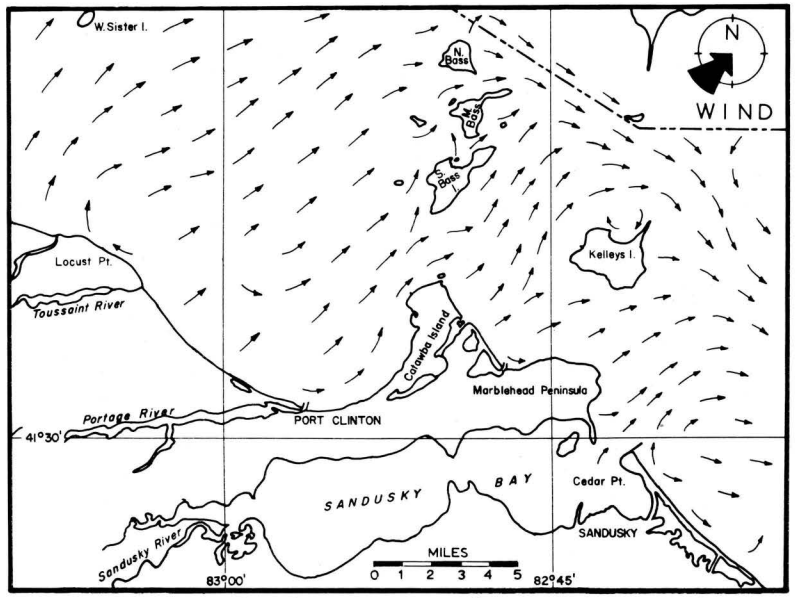


H, Generalized bottom currents, moderate southeast wind

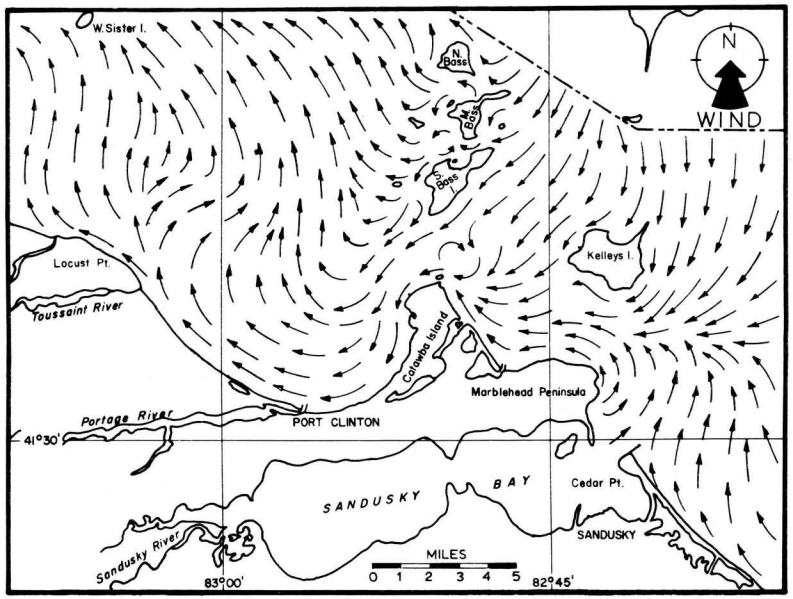
FIGURE 11.–Generalized current diagrams for western basin of Lake Erie–*Continued*



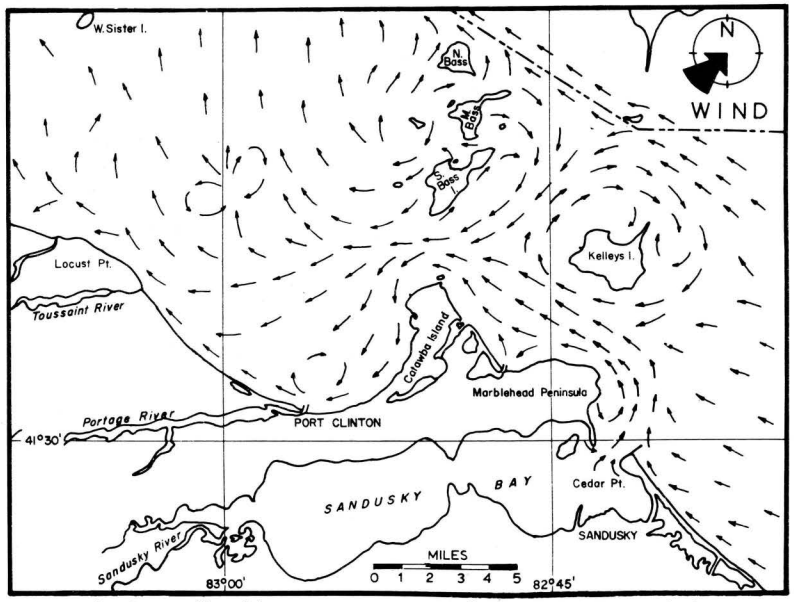
I, Generalized surface currents, moderate south wind



K, Generalized surface currents, moderate southwest wind

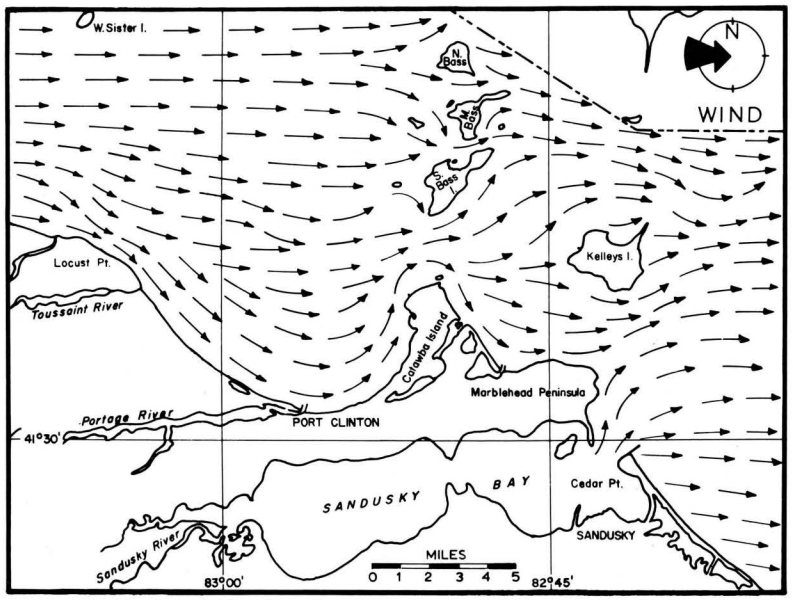


J, Generalized bottom currents, moderate south wind

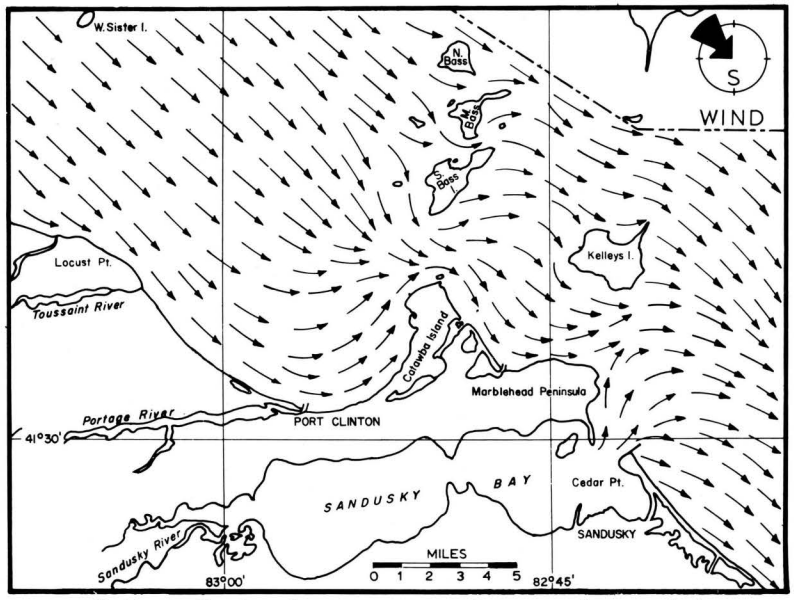


L, Generalized bottom currents, moderate southwest wind

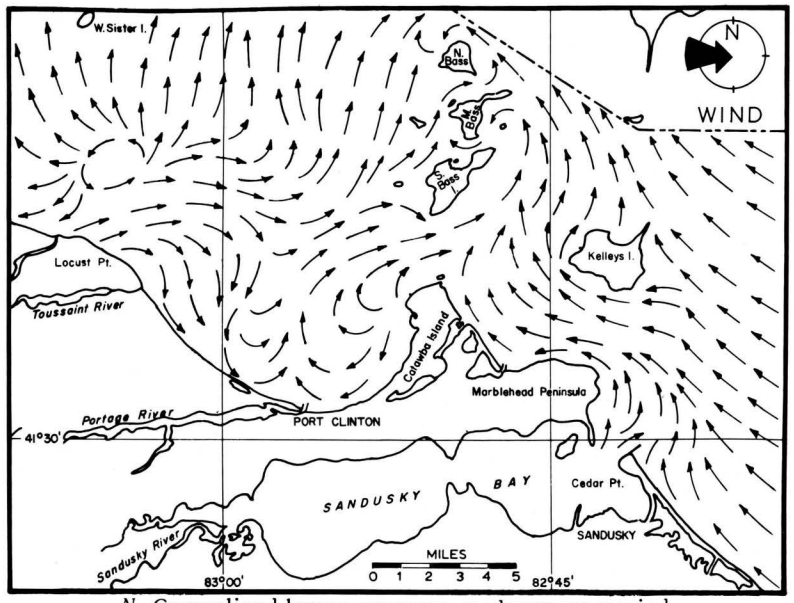
FIGURE 11.–Generalized current diagrams for western basin of Lake Erie–*Continued*



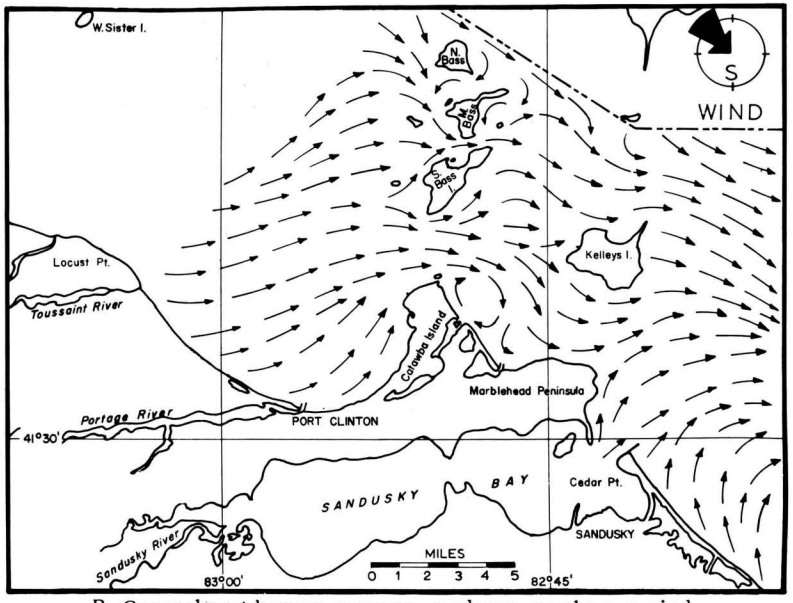
M, Generalized surface currents, moderate west wind



O, Generalized surface currents, moderate northwest wind

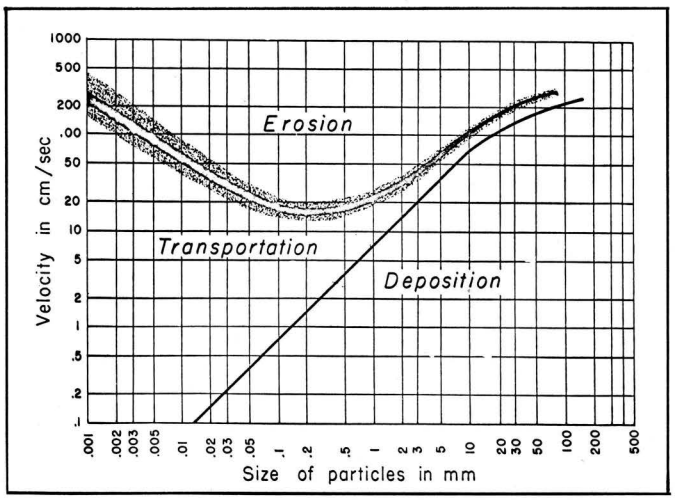


N, Generalized bottom currents, moderate west wind



P, Generalized bottom currents, moderate northwest wind

FIGURE 11.–Generalized current diagrams for western basin of Lake Erie–*Continued*



Current velocity conversion table

knots	ft/sec	cm/sec	knots	ft/sec	cm/sec
0.01	0.02	0.52	1.10	1.86	56.63
0.10	0.17	5.15	1.20	2.03	61.78
0.20	0.34	10.30	1.30	2.20	66.96
0.30	0.51	15.45	1.40	2.37	72.09
0.40	0.68	20.60	1.50	2.53	77.24
0.50	0.84	25.76	1.60	2.70	82.36
0.60	1.01	30.88	1.70	2.87	87.51
0.70	1.18	36.02	1.80	3.04	92.66
0.80	1.35	41.18	1.90	3.21	97.81
0.90	1.52	46.33	2.00	3.38	102.96
1.00	1.69	51.48			

FIGURE 12.—Current velocities at which various size grades of sediment will be eroded, transported, or deposited (Dunbar and Rodgers, 1957; modified from Hjulström, 1945).

period of several weeks, as heating progresses, the thermal bar moves toward the middle of the lake in a contracting motion.

Water temperatures for 1967-1969 at Put-in-Bay (table 15) and at four reefs (table 16) do not show a clear example of a thermal bar moving through the reef area. There is a general indication that the water temperatures are slower to rise at Put-in-Bay and West Reef than at the nearshore reefs. It appears likely that an idealized thermal structure does not develop in the western basin because of the disruptive influence of the Detroit River flow, the shallow bottom topography, and the islands and reefs. Usually the reef area is nearly isothermal from surface to bottom throughout the year, with seasonal heating and cooling being gradual. Diurnal microthermoclines are common in the summer, but prolonged periods of hot calm weather can cause temporary thermal stratification, due to the heating of the surface waters without the benefit of mixing.

In the summer of 1953 a prolonged period of very calm weather resulted in thermal stratification that was accompanied by severe oxygen depletion in the bottom water. Britt (1955) found that after the stratification the mayfly *(Hexagenia)* population was about one-tenth of its original size.

Again in June 1963, after four consecutive days of daytime temperatures over 90°F, with only light and variable winds, marked thermal stratification was observed in western Lake Erie by Carr, Applegate, and Keller (1965). The maximum thermal gradient was 2°F per foot and the maximum temperature difference between surface and bottom water was 12°F. Depletion of dissolved oxygen in the hypolimnion was also associated with the temporary stratification.

Other physicochemical water properties

Specific conductance (conductivity) yields a measurement of the capacity of water to convey an electrical current. This property is related to concentration of dissolved substances in the water and to its temperature. The conductivity of a particular water sample depends on the nature of the ion present; therefore, no universal relationship can be determined for the ratio of specific conductance (SC) to total dissolved solids (TDS). Data from 1963 and 1964 studies by the Federal Water Pollution Control Administration (1968a)

TABLE 15.—*Average temperatures at Put-in-Bay State Fish Hatchery*

		1967		1968		1969	
		Water (°F)	Air (°F)	Water (°F)	Air (°F)	Water (°F)	Air (°F)
Jan.	1-15	33.2	30.6	32.9	17.5	33.0	16.2
	16-31	33.4	33.4	33.2	30.3	33.3	31.9
Feb.	1-15	33.0	27.3	33.7	27.3	33.4	27.3
	16-28/29	33.2	24.8	33.9	25.9	33.9	33.7
March	1-15	33.3	33.4	34.5	33.1	34.2	32.5
	16-31	35.0	37.3	35.9	43.9	36.7	40.3
April	1-15	44.5	50.7	46.1	54.1	43.0	47.0
	16-30	49.6	49.9	52.2	53.5	48.5	51.5
May	1-15	51.9	51.5	54.6	56.6	54.8	56.7
	16-31	56.9	59.4	59.1	59.1	59.7	63.9
June	1-15	66.4	77.0	67.1	73.3	63.1	64.3
	16-30	70.8	75.5	68.3	68.3	65.5	69.3
July	1-15	72.6	73.2	71.1	76.4	71.4	73.9
	16-31	74.0	76.4	75.7	77.8	74.7	78.6
Aug.	1-15	74.3	75.1	76.1	78.3	75.6	78.3
	16-31	71.8	72.6	76.6	78.3	75.8	79.3
Sept.	1-15	70.1	69.6	70.7	71.5	72.8	74.3
	16-30	64.5	62.2	68.7	71.3	65.8	64.5
Oct.	1-15	57.2	60.9	62.0	62.9	62.7	64.1
	16-31	52.4	52.6	57.1	55.3	53.3	50.5
Nov.	1-15	45.8	41.5	48.7	46.5	47.7	47.5
	16-30	38.6	35.8	42.5	42.4	40.2	37.2
Dec.	1-15	36.7	37.5	36.7	32.3	34.3	32.0
	16-31	34.7	30.8	33.3	25.8	32.9	25.0
Yearly average		51.4	51.6	52.9	52.6	51.9	51.7

TABLE 16.—*Average spring temperatures for bottom water at four reefs in western Lake Erie*

Period	Starve Island Reef			West Reef		Crib Reef			Toussaint Reef		
	1967	1968	1969	1967	1968	1967	1968	1969	1967	1968	1969
	Temperatures (°F)										
April 1-7	40.3	46.6	39.2	41.3	42.1	--	42.3	37.2	45.3	41.4	35.8
8-15	41.6	49.0	42.3	43.2	45.9	47.8	49.3	41.6	47.0	48.3	41.3
16-22	47.0	49.3	46.1	47.4	49.1	51.0	52.6	47.7	51.1	52.0	46.0
23-30	48.4	50.3	49.4	49.0	51.4	49.0	53.1	48.8	49.5	51.6	48.5
May 1-7	49.6	53.0	52.1	50.0	53.3	51.9	54.6	53.3	51.9	53.1	53.7
8-15	50.5	54.5	55.2	51.0	55.3	51.9	57.1	56.6	51.9	56.1	55.8
16-22	49.0	56.7	57.6	54.0	57.4	54.9	59.7	58.6	54.1	58.7	57.0
23-31	49.0	--	58.5	58.2	59.3	59.0	59.4	60.2	58.6	59.3	58.7
June 1-7	--	62.8	61.4	63.7	62.9	63.4	63.6	63.9	62.7	62.3	62.1
8-15	--	64.3	62.0	70.4	71.8	71.5	70.8	64.9	71.1	67.5	63.1
16-22	--	66.0	--	72.0	68.3	73.9	69.0	--	76.0	68.3	--
23-30	--	--	--	72.4	67.9	73.9	69.1	--	72.2	70.0	--
July 1-7	--	--	--	73.9	69.5	73.9	70.2	--	72.7	70.4	--
Spring average	46.9	55.3	52.4	57.4	58.0	60.2	59.3	53.3	58.8	58.4	52.2

showed that the average TDS/SC ratio was 0.60 for western Lake Erie.

The mean conductivity in the reef area was 257 micromhos/cm (TDS, 154 ppm) for surface water and 277 micromhos/cm (TDS, 166 ppm) for bottom water. Station 35, Sandusky Bay mouth, had the highest average readings; stations 11 and 29, north-central part of the study area, had the lowest average readings (table 17).

The water in the reef area of western Lake Erie is characterized by low transparency (table 17). The lowest average reading was 1.9 feet, taken at station 22 near the mouth of the Toussaint River, and the highest average reading was 9.0 feet, obtained at station 26 east of Niagara Reef.

The results of very limited determinations of water chemistry are presented in table 18. The only significant generalizations that can be made about the water in the reef area are that (1) the water is bicarbonate (average total alkalinity, as $CaCO_3$, 94.5 ppm), (2) the observed dissolved-oxygen concentrations showed no serious depletion, (3) the pH of the water is moderately basic (average 8.4), and (4) the concentrations of dissolved solids in the water indicate considerable enrichment (Federal Water Pollution Control Administration, 1968a, b).

SUMMARY AND CONCLUSIONS

The Great Lakes owe their origin to physiographic changes induced by Pleistocene glaciation. As the ice sheets paused in their advance or retreat, ridges or moraines of glacial till were built up at their margins, damming the natural drainage and forming large glacial lakes. Lake Erie is the remnant of such a lake, which at its highest stage (Lake Maumee I) extended as far southwest as Fort Wayne, Indiana. As the ice retreated, other outlets were uncovered and new lake stages were formed at successively lower levels, except when minor readvances of the ice blocked outlets and caused temporarily higher levels.

When the last glacier retreated from the vicinity of Buffalo, New York, a new drainage outlet was made available via the Niagara River. However, at that time the Buffalo area was as much as 100 feet lower than at present because of the depression caused by the weight of glacial ice (Lewis *et al.*, 1966) and this new outlet resulted in the draining of the western basin and the formation of relatively shallow lakes in the central and eastern basins. The outlet gradually rebounded to its present elevation and Lake Erie correspondingly rose from the low stage of that time to the modern level.

During low lake stages (11,300-4,300 B.P.) much of the present lake bottom in the western basin was exposed to subaerial erosion, which greatly altered and reshaped the till surface. It appears that at this time a valley system was cut into the till surface. Such a valley is shown in the vicinity of station WR-8 (fig. 5). This drainage pattern, as was the preglacial system, was strongly controlled by the topographic bedrock highs. During the low stages, shallow ephemeral lakes appear to have occupied depressions in the till surface; considerable amounts of plant detritus accumulated in the depressions.

In the interval since the drainage of the large glacial lakes waves and currents of modern Lake Erie have cut into the lake deposits, locally excavating the surficial glacial deposits and exposing the least deeply buried bedrock. The elongated shape and northeast-southwest orientation of the islands and reefs are controlled by (1) the relative resistance and the structure of the bedrock and (2) the direction of movement and scouring effect of the glaciers. The predominant southwest or northeast winds (42 percent) and the resulting

southwest or northeast seiche and current movements (44 percent) may also have had some effect on their elongated shape.

Most of the coarse material which the waves and currents have eroded from the till has either been deposited as sand and gravel beaches or has remained as lag deposits in the shallow offshore reef areas. The finer eroded sediment has been deposited as muds in the deeper offshore areas.

TABLE 17.—*Average conductivity and transparency measurements in the reef area of western Lake Erie*

Station number	Conductance (micromhos/cm)		Transparency (ft)
	Surface	Bottom	
1	254	295	3.8
2	250	311	6.0
3	263	297	5.2
4	256	278	5.1
5	259	269	4.7
6	251	268	5.8
7	245	264	5.9
8	245	253	6.2
9	245	303	6.7
10	235	273	7.4
11	219	235	5.8
12	224	282	5.0
13	232	243	5.5
14	245	295	5.6
15	273	277	3.1
16	279	291	3.6
17	248	291	5.0
18	241	265	5.4
19	252	259	5.4
20	257	273	3.6
21	251	258	3.6
22	282	289	1.9
23	253	262	2.4
24	241	246	6.2
25	254	258	4.8
26	244	317	9.0
27	244	266	6.7
28	263	267	3.7
29	215	238	6.3
35	415	368	
36			3.5
37			4.1
39	288	272	
45			5.7
46			4.9
47	292	299	3.9
48			3.7
49			6.5
50			3.0
51	260	282	3.3
52	245	270	2.9
53			3.1
54			6.2
55			5.9
56			5.5
57			6.6
58	261	271	4.7
59			3.5
60			3.8
61	284	293	
68	260	280	—
Average	257	277	4.9

The muds in the deeper waters (25-35 feet) of the western part of the study area contain a high percentage of silt-sized grains, normally over 95 percent, and very low percentages of clay-sized material. However, U.S. Geological Survey records (table 3) for the Portage and Sandusky Rivers show that over 60 percent of the material carried by the rivers to the lake during the period 1950 to 1956 fell within the clay size range (R. F. Flint, personal communication). Also, the underlying till averages approximately 33 percent clay-sized particles. The compact lake clay sediments between the muds and the till contain about 38 percent clay-sized material.

TABLE 18.—*Chemical limnology measurements in the reef area of western Lake Erie*

Chemical parameter	Number of determinations		Mean values	
	Surface water	Bottom water	Surface water	Bottom water
Alkalinity, phenol. (ppm)	34	40	2.9	1.6
Alkalinity, total (ppm)	34	40	94.1	94.8
Chloride ion (ppm)	41	38	25.0	24.3
Copper (ppm)	10	12	0.06	0.12
Hardness, calcium (ppm)	22	30	95.2	92.8
Hardness, total (ppm)	22	30	127.0	125.7
Hydrogeon ion (pH)	57	62	8.47	8.36
Hydrogen sulfide (ppm)	2	2	0.0	0.0
Iron (ppm)	2	6	0.11	0.10
Oxygen, dissolved (ppm)	60	65	9.6	8.4
Silica (ppm)	1	3	1.4	0.7
Sulfate (ppm)	2	2	27.5	27.5
Turbidity (jtu)	58	61	11.5	16.6

The most likely explanation for the lack of clay in recent sediments appears to be the present shallow condition of western Lake Erie; this allows waves and currents to affect the water column to the bottom of the lake. Conditions are not of the quiet nature needed for deposition of clay-sized particles (fig. 12). Apparently the clay-sized material is carried out of the western basin for deposition in the deeper waters of central Lake Erie. This contention is substantiated by the increase in clay-sized bottom material in the deeper water areas of the eastern part of the study area (table A, Appendix). The lake clay sediments underlying the surface muds were apparently deposited in the deeper glacial lakes, the highest of which was over 230 feet deeper than modern Lake Erie. Under these conditions clay could easily have been deposited in the area presently occupied by the western basin.

Another possible explanation of the low clay content found in surface samples may be the presence of silt-sized aggregates, composed of clay-sized parti-

cles, which were formed by bacteria and algae. It is possible that the sample preparation method used for hydrometer analysis is ineffective in dispersing the aggregate. This may partially account for the low clay content in the surface muds when compared with the underlying deposits and the sediments contributed by streams of the study area.

A radiocarbon date of 6,550 years B.P. obtained from a sample of oak wood taken 23 feet below the lake bottom north of Port Clinton (I-57) allows a straight line calculation of a sedimentation rate of 0.35 ft/century. Other radiocarbon dates (9,440-4,335 years B.P.) from samples west of Middle Bass Island (WR-31, 32, 33, and 34) yield sedimentation rates that range from 0.11 to 0.26 ft/century.

All of the submerged rock exposures within the reef area project above the surrounding bottom and are generally free of sediment. The surfaces of the reefs are apparently swept clean by rapid currents, which indicates that no permanent sedimentation is taking place in these areas. However, the large amounts of material retrieved from the sediment collectors indicate that a considerable amount of sediment is probably being transported through the reef area to be deposited in deeper water. The coarse-grained lag deposits adjacent to the reefs are also indicative of high wave and current energy areas which are not now subject to permanent siltation.

Currents in the vicinity of the islands and reefs appear to be directly related to wind-produced seiche activity and to water-level fluctuations. Surface currents are normally driven by the wind while subsurface seiche currents are often opposed to the wind in the form of a compensating return flow. Seiche currents apparently do not result in a net transport of water because of their to-and-fro motion. The shallowness of the western basin allows such current activity to affect the entire water column, producing nearly isothermal conditions throughout the year.

The lack of permanent siltation on the bedrock and gravel reef areas makes them the only suitable sites for "clean water" benthic organisms such as certain mayflies, caddisflies, isopods, and amphipods. These organisms are important in the food web of many of the commercial fish species. The absence of these animals on and in the mud bottoms limits the feeding grounds to the reefs.

The reef areas project above the bottom and they are generally areas of higher energy due to the force of waves and currents. These factors allow simulation of the environment found in the riffles of streams. Several fish species, particularly the walleye, appeared to have enjoyed success in Lake Erie because of the availability of this type of habitat.

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APPENDIX

APPENDIX

TABLE A.—*Analyses of surface sediment samples*

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
1		2.0	19.8	71.6	6.6	5YR 3/4	5.5
2		56.3	42.0	1.7		10YR 5/2	7.4
3		47.8	51.3	0.9		10YR 5/2	9.2
4		8.2	87.7	4.1		10YR 5/2	11.6
5		94.8	5.2			10YR 5/2	13.0
6		5.7	92.7	1.6		10YR 5/2	16.6
7		57.3	40.8	1.9		10YR 5/4	17.0
8		72.2	26.3	1.5		10YR 5/2	19.1
9		100.0				10YR 5/4	20.4
10		6.5	20.3	67.0	6.2	N 4	23.1
11		6.9	48.7	44.4		5GY 5/1	23.1
12		36.7	49.6	13.7		5Y 6/1	22.4
13			16.1	83.9		5GY 5/1	25.0
14		3.8	61.9	28.7	5.6	N 5	25.6
15			9.3	83.6	7.1	N 5	26.0
16			3.2	90.9	5.9	5GY 5/1	26.0
17			7.7	85.1	7.2	5GY 5/1	26.2
18			4.6	95.4		5GY 5/1	27.6
19			0.5	99.5		5GY 5/1	27.8
20			1.3	98.7		5GY 5/1	28.6
21			0.5	99.5		5GY 5/1	28.1
22			0.6	99.4		5GY 5/1	26.5
23		5.2	5.6	89.2		5Y 5/1	25.8
24			1.1	98.9		5GY 5/1	26.6
25			13.3	86.7		5GY 5/1	26.1
26		10.0	46.1	43.9		2.5Y 3/1	25.0
27		12.3	82.1	5.6		5GY 6/1	22.6
28		100.0				10YR 4/4	19.4
29		77.1	19.6	3.3		10YR 5/2	21.9
30		47.2	48.7	4.1		10YR 5/2	19.7
31		70.6	29.4			10YR 5/4	18.7
32		42.8	54.9	2.3		10YR 5/2	17.2
33		73.7	24.3	2.0		10YR 5/2	16.2
34		91.5	8.5			10YR 5/2	13.2
35		89.1	9.3	1.6		10YR 5/3	11.6
36		33.6	63.9	2.5		10YR 5/2	9.5
37		16.1	82.3	1.6		10YR 5/4	8.4
38		3.9	85.3	10.8		10YR 4/2	5.5
39		6.3	38.2	55.5		10YR 4/2	4.1
40		44.6	52.8	2.6		10YR 5/2	8.7
41		44.3	53.1	2.6		10YR 5/4	9.7
42		96.2	3.4	0.4		10YR 5/2	10.9
43		32.4	66.6	1.0		10YR 5/2	12.8
44		66.6	31.4	2.0		10YR 5/3	16.3
45		95.3	4.7			10YR 5/3	17.3
46		97.9	1.3	0.8		2.5YR 5/4	20.1
47		32.1	67.9			10YR 4/4	20.0
48		64.2	34.6	1.2		10YR 5/4	20.9
49		31.0	68.1	0.9		10YR 4/3	20.4
50		11.3	88.2	0.5		10YR 4/3	22.3
51			3.2	96.8		5GY 5/1	25.5
52			2.0	98.0		5GY 5/1	26.5
53			0.7	95.3	4.0	5GY 5/1	27.4
54			0.5	99.5		5GY 5/1	27.4
55			9.9	25.2	64.9		5GY 5/1	25.9
56				5.9	94.1		5GY 5/1	30.0
57				1.2	98.8		5GY 5/1	29.6
58				0.2	93.8	6.0	5GY 5/1	29.8
59				0.7	97.2	2.1	5GY 6/1	29.4
60				1.1	98.9		5GY 5/1	25.0
61				0.7	99.3		5GY 5/1	28.1
62				0.5	99.5		5GY 5/1	27.4
63				0.4	90.0	9.6	5GY 5/1	26.7
64				0.4	99.6		5GY 5/1	25.7
65			2.6	27.6	69.8		5GY 5/1	25.1
66			4.9	94.5	0.6		7.5YR 3/2	22.9
67			9.5	90.2	0.3		7.5YR 4/4	20.8
68			39.6	58.7	1.7		7.5YR 4/4	20.6
69			95.4	4.6			10YR 4/3	19.5
70			98.1	1.9			10YR 5/4	17.3
71			50.5	49.5			10YR 5/4	16.5
72			92.4	7.6			10YR 5/3	13.1
73			98.0	2.0			10YR 6/3	11.5
74			9.8	90.2			10YR 5/4	10.3
75			87.9	12.1			10YR 5/2	9.6
76			0.6	99.4			10YR 4/2	4.6
77				86.7	13.3		2.5Y 3/2	3.1
78			74.9	25.1			10YR 5/1	9.7
79			37.8	58.7	3.5		10YR 5/2	9.6
80			96.7	3.3			10YR 5/2	10.7
81			22.8	73.9	3.3		10YR 5/1	12.6
82			15.7	79.4	4.9		10YR 5/1	14.6
83			24.7	74.1	1.2		10YR 5/2	16.4
84			87.0	12.1	0.9		10YR 5/3	17.6
85			89.1	10.9			10YR 5/2	21.0
86			2.1	97.2	0.7		10YR 5/1	22.2
87				64.2	35.8		5GY 4/1	24.1
88				22.5	77.5		5GY 5/1	24.7
89			2.9	14.0	83.1		5GY 5/1	25.8
90				3.5	93.0	3.5	5GY 5/1	26.6
91				1.5	98.5		5GY 5/1	27.5
92				1.0	95.0	4.0	5GY 5/1	28.0
93				0.6	92.6	6.8	5GY 5/1	27.9
94				1.4	94.7	3.9	5GY 5/1	26.3
95				1.6	98.4		5GY 5/1	27.9
96				0.3	99.7		5GY 5/1	29.0
97				0.9	99.1		5GY 5/1	29.3
98				0.6	99.4		5GY 4/1	27.6
99				0.3	99.7		5Y 5/1	26.8
100				0.3	99.7		5Y 5/1	27.4
101				0.3	99.7		5GY 5/1	27.8
102				0.3	99.7		5GY 5/1	26.9
103				0.6	99.4		5Y 5/1	26.9
104			1.3	18.0	78.7	2.0	5Y 5/1	26.1
105				37.9	62.1		5GY 5/1	25.2
106				7.4	90.0	2.6	5GY 4/1	24.5
107				8.0	92.0		5GY 4/1	23.9
108			96.0	4.0			10YR 5/4	21.1

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
109		99.9	0.1			mixed	19.3
110		30.6	66.2	3.2		5Y 6/1	16.9
111		85.1	14.6	0.3		10YR 5/2	13.9
112		45.5	54.5			10YR 5/2	12.1
113		41.7	54.9	3.4		10YR 5/2	10.1
114		68.7	29.6	1.7		10YR 5/2	10.1
115		3.4	93.8	2.8		10YR 5/4	8.1
116		16.5	50.7	32.8		2.5Y 3/2	14.2
117		1.0	19.6	79.4		2.5Y 3/2	8.6
118				100.0		10YR 6/3	5.2
119		85.9	12.6	1.5		10YR 5/4	12.2
120		16.9	82.4	0.7		10YR 5/2	11.8
121		96.7	3.3			10YR 2/2	12.0
122		88.6	11.3	0.1		10YR 5/2	14.5
123		97.4	2.6			5Y 5/1	11.7
124		92.7	7.3			10YR 5/4	19.2
125		22.8	67.1	10.1		10YR 5/2	20.3
126		83.0	15.9	1.1		10YR 5/1	22.5
127			9.3	88.1	2.6	5Y 5/1	24.4
128			14.4	85.6		5GY 4/1	25.1
129			31.9	68.1		5GY 5/1	25.5
130			2.0	95.7	2.3	5GY 5/1	26.5
131			0.9	99.1		5GY 5/1	27.2
132			1.2	94.9	3.9	5GY 4/1	27.9
133			0.4	99.6		5Y 4/1	27.9
134			0.5	99.5		5Y 5/1	27.4
135			0.3	99.7		5Y 5/1	27.4
136			0.7	99.3		5GY 5/1	28.0
137			0.3	99.7		5GY 5/1	30.3
138			0.3	99.7		5GY 5/1	28.5
139			0.3	96.2	3.5	5GY 5/1	27.8
140			0.3	97.0	2.7	5Y 5/1	27.2
141			0.5	95.1	4.4	5Y 5/1	26.8
142			0.3	99.7		5GY 5/1	27.8
143			0.3	94.1	5.6	5GY 5/1	27.9
144			0.7	94.5	4.8	5GY 5/1	27.3
145			0.9	92.4	6.7	5GY 5/1	26.3
146			15.5	79.6	4.9	5GY 5/1	25.5
147			11.3	88.7		5Y 4/1	25.0
148			8.2	91.8		5Y 4/1	24.6
149			6.2	86.1	7.7	5GY 5/1	24.4
150		89.7	8.7	1.6		10YR 5/4	21.3
151		79.1	19.7	1.2		5Y 5/1	19.3
152		100.0				5YR 5/3	18.0
153		63.6	35.0	1.4		10YR 5/2	16.0
154		100.0				5YR 5/3	13.3
155		54.9	43.5	1.6		10YR 5/4	11.7
156		1.2	98.6	0.2		10YR 4/4	12.0
157		42.5	55.8	1.7		10YR 5/4	10.2
158		9.4	87.9	2.7		10YR 5/4	11.2
159		2.1	86.6	11.3		2.5Y 3/2	8.6
160		11.0	88.2	0.8		5Y 4/1	1.6
161			98.0	2.0		2.5Y 3/2	11.6
162			89.4	10.6		10YR 5/4	11.1
163			99.0	1.0		10YR 5/4	10.2
164		19.0	63.5	17.5		10YR 5/2	11.5
165		11.3	88.7			10YR 5/4	13.6
166		95.6	4.4			10YR 5/2	13.5
167		100.0				mixed	15.6
168		100.0				10YR 5/3	16.2
169		23.8	72.7	3.5		10YR 5/4	19.2
170		81.1	18.3	0.6		10YR 5/1	20.1
171	100.0					no sample	18.7
172				5.4	94.6	5GY 5/1	25.2
173				4.2	92.2	3.6	5GY 4/1	24.6
174				11.0	86.4	2.6	5GY 4/1	25.0
175				21.4	78.6		5GY 5/1	25.6
176				2.0	98.0		5GY 5/1	26.6
177				1.0	99.0		5GY 5/1	27.6
178				0.4	99.6		5GY 4/1	27.8
179				0.3	99.7		5GY 4/1	27.6
180				1.6	98.4		5GY 5/1	27.3
181				0.6	99.4		5GY 5/1	27.8
182				0.4	99.6		5Y 5/1	28.7
183				0.5	96.2	3.3	5GY 5/1	29.0
184				0.3	99.7		5GY 5/1	29.2
185				0.8	99.2		5GY 5/1	29.1
186				0.3	99.7		5GY 5/1	28.6
187				0.4	99.6		5GY 5/1	27.9
188				0.5	99.5		5GY 5/1	27.6
189				0.3	99.7		5GY 4/1	27.7
190				0.3	99.7		5GY 5/1	28.1
191				0.5	94.6	4.9	5GY 5/1	28.0
192				1.0	99.0		5GY 5/1	27.0
193				6.3	93.7		5GY 5/1	26.2
194				5.1	91.4	3.5	5GY 4/1	26.1
195				1.6	98.4		5GY 5/1	26.0
196	100.0					no sample	22.3
197		100.0				7.5R 4/4	21.4
198		100.0				7.5YR 4/4	19.2
199		100.0				7.5YR 8/2	17.2
200		68.8	28.2	3.0		2.5Y 4/2	14.9
201		86.8	9.8	3.4		2.5Y 4/2	14.0
202		0.2	99.1	0.7		2.5Y 4/2	14.7
203			99.6	0.4		10YR 5/4	10.8
204			42.0	58.0		5GY 5/1	11.7
205			33.2	66.8		5Y 5/1	11.0
206			14.9	85.1		5Y 5/1	10.0
207		0.3	98.2	1.5		10YR 5/4	5.7
208			12.0	88.0		10YR 5/4	9.6
209			97.1	2.9		2.5Y 3/2	2.6
210		30.4	59.9	9.7		2.5Y 3/2	12.6
211			61.5	38.5		5Y 5/1	13.6
212			51.0	49.0		5Y 5/1	10.7
213		0.1	87.1	12.8		2.5Y 3/2	14.7
214		0.8	98.4	0.8		10YR 5/4	14.6
215		12.4	86.4	1.2		10YR 5/2	15.1
216		0.7	97.7	1.6		10YR 5/2	15.4
217		0.1	99.7	0.2		10YR 5/2	15.0
218		86.4	12.7	0.9		10YR 5/2	14.3
219		88.1	9.7	2.2		10YR 5/4	14.8
220		89.1	9.2	1.7		10YR 5/2	16.6
221		100.0				10YR 8/3	16.3
222		63.9	33.2	2.9		10YR 5/2	19.6
223		50.6	42.6	6.8		10YR 4/4	20.1
224			16.9	83.1		5GY 5/1	26.0
225			5.7	94.3		5GY 4/1	26.2
226			4.7	95.3		5GY 4/1	26.8
227			1.3	98.7		5GY 5/1	27.8
228			0.4	94.7	4.9	5GY 5/1	28.2
229			0.5	99.5		5GY 5/1	28.5
230			0.4	89.0	10.6	5GY 5/1	27.7
231			0.4	81.1	18.5	5GY 5/1	29.0
232			0.9	99.1		5GY 5/1	28.7

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
233			0.8	93.8	5.4	5GY 5/1	29.3
234			0.4	90.3	9.3	5GY 5/1	29.9
235			0.4	99.6		5GY 5/1	29.6
236			0.4	99.6		5BG 4/1	30.2
237			0.4	99.6		5GY 5/1	29.9
238			0.5	99.5		5GY 5/1	29.8
239			0.4	99.6		5GY 5/1	29.5
240			0.4	99.6		5GY 5/1	28.9
241			0.7	99.3		5GY 5/1	27.7
242			0.3	99.7		5GY 5/1	28.5
243			0.4	99.6		5GY 5/1	28.4
244			0.5	99.5		5GY 4/1	28.2
245			0.5	99.5		5GY 5/1	27.6
246			1.2	98.8		5GY 5/1	27.5
247	100.0					no sample	21.5
248		81.7	10.2	8.1		10YR 5/4	22.3
249	100.0					no sample	18.7
250		83.3	16.7			10YR 4/3	17.8
251		54.9	20.6	24.5		10YR 7/3	16.9
252		53.7	25.3	21.0		10YR 5/4	14.3
253		80.7	16.9	2.4		5Y 5/1	11.8
254			98.1	1.9		10YR 5/4	14.7
255		45.9	52.2	1.9		5Y 5/1	13.6
256		10.9	80.8	8.3		10YR 5/2	14.5
257			99.1	0.9		10YR 5/2	14.2
258			51.3	48.7		5GY 5/1	15.6
259			57.1	42.9		5Y 4/2	13.0
260			36.3	63.7		5Y 4/2	14.6
261			40.6	59.4		5GY 5/1	13.8
262		17.6	30.5	48.4	3.5	2.5Y 3/2	12.6
263		13.5	42.7	43.8		10YR 4/2	9.6
264			12.5	87.5		5BG 4/1	15.5
265		1.1	42.5	56.4		5BG 4/1	15.5
266		5.9	49.4	44.7		N 4	15.1
267			71.9	28.1		5GY 5/1	13.9
268			32.5	67.5		5G 5/1	17.0
269			72.9	27.1		5GY 5/1	15.6
270			98.5	1.5		5Y 5/1	14.1
271			99.0	1.0		5Y 5/1	12.8
272		75.0	25.0			5Y 5/1	12.3
273	100.0					no sample	10.7
274	100.0					no sample	10.7
275		72.7	25.7	1.6		5GY 5/1	16.7
276		100.0				mixed	18.1
277		100.0				mixed	18.0
278		3.4	33.8	62.8		5BG 5/1	23.1
279		99.9	0.1			mixed	24.6
280		9.5	66.5	24.0		5BG 5/1	26.3
281			9.3	90.7		5BG 5/1	27.6
282			4.3	90.2	5.5	5BG 5/1	28.4
283			1.5	98.5		5B 4/1	28.3
284			0.4	95.6	4.0	5B 4/1	28.3
285			0.4	99.6		5BG 5/1	28.1
286			0.4	99.6		5BG 5/1	28.8
287			0.4	99.6		5BG 5/1	28.8
288			0.3	99.7		5BG 5/1	29.6
289			0.3	99.7		5GY 5/1	29.5
290			2.8	78.6	18.6	5GY 4/1	29.5
291			0.3	96.5	3.2	5GY 5/1	29.7
292			6.2	93.8		5GY 5/1	29.6
293			1.8	98.2		5GY 5/1	30.0
294			1.2	98.8		5GY 4/1	29.9
295			1.0	99.0		5BG 4/1	29.3
296			0.3	99.7		5GY 5/1	28.8
297			1.0	99.0		5GY 5/1	28.8
298			0.5	99.5		5GY 4/1	28.5
299			0.4	99.6		5Y 5/1	28.1
300			0.3	94.2	5.5	5GY 5/1	28.0
301			1.6	94.2	4.2	5GY 4/1	27.7
302		9.9	22.3	67.8		5GY 4/1	26.5
303			5.0	95.0		5GY 4/1	27.7
304			11.3	88.7		5BG 4/1	27.2
305	100.0					no sample	6.5
306		100.0				5Y 6/1	14.0
307		51.3	47.1	1.6		5Y 5/1	15.3
308			99.7	0.3		N 5	15.3
309			98.5	1.5		10YR 5/2	12.2
310			99.0	1.0		10YR 5/3	11.4
311			98.8	1.2		5BG 4/1	13.7
312			42.9	57.1		5B 4/1	17.1
313			14.7	85.3		5GY 4/1	18.2
314		0.3	44.5	53.2	2.0	5Y 4/1	15.0
315		0.1	54.3	45.6		5GY 4/1	16.3
316			34.6	65.4		5BG 4/1	15.7
317			17.9	82.1		5BG 4/1	16.2
318			11.1	88.9		2.5Y 3/2	13.6
319		0.4	97.8	1.8		2.5Y 4/2	0.5
320			98.3	1.7		2.5Y 4/2	0.3
321		79.9	19.6	0.5		mixed	12.4
322		1.9	22.7	75.4		5GY 4/1	16.8
323			6.1	93.9		5GY 5/1	17.4
324			31.4	68.6		5GY 5/1	17.6
325			30.6	69.4		5GY 5/1	17.5
326			32.4	67.6		5GY 5/1	16.7
327			12.0	88.0		2.5Y 3/2	19.0
328			99.4	0.6		5Y 5/1	14.0
329		8.1	90.0	1.9		5Y 5/1	17.0
330		1.1	97.5	1.4		5GY 5/1	18.9
331		74.7	24.7	0.6		5Y 4/1	18.3
332		61.4	28.1	10.5		5Y 5/1	19.0
333	100.0					no sample	20.0
334			100.0			2.5Y 5/4	22.8
335			100.0			5Y 7/1	23.5
336			100.0			5Y 7/1	25.1
337			1.3	51.4	47.3	5GY 5/1	28.2
338		27.1	50.2	21.7		5GY 5/1	27.0
339			3.7	96.3		5GY 4/1	27.9
340			0.4	99.6		5BG 4/1	28.6
341			0.7	99.3		5BG 4/1	28.7
342			0.3	99.7		5BG 4/1	28.8
343			1.7	98.3		5BG 4/1	28.9
344			2.0	98.0		5G 5/1	29.1
345			0.4	99.6		5GY 5/1	29.2
346			1.8	98.2		5GY 5/1	29.5
347			0.6	99.4		5GY 5/1	29.7
348			0.7	99.3		5GY 5/1	29.6
349		0.3	0.3	96.1	3.3	5G 5/1	29.9
350			1.5	98.5		5GY 5/1	30.6
351			0.5	99.5		5GY 5/1	30.3
352			1.1	98.9		5GY 5/1	30.6
353			1.0	99.0		5GY 5/1	30.6
354			0.8	99.2		5GY 5/1	29.6
355			0.3	99.7		5GY 4/1	29.7
356			0.3	99.7		5GY 5/1	29.6

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
357			0.8	69.6	29.6	5GY 4/1	29.2
358		4.0	2.9	93.1		5GY 5/1	28.9
359			0.4	99.6		5GY 4/1	29.1
360			0.6	99.4		5GY 4/1	28.8
361			0.6	99.4		5GY 5/1	24.7
362		100.0				10YR 5/3	19.4
363		4.7	89.6	5.7		5GY 5/1	23.0
364		72.2	26.9	0.9		7.5YR 4/2	20.3
365		15.3	83.2	1.5		5GY 5/1	20.7
366		4.9	78.1	17.0		5Y 4/1	21.2
367		78.4	18.6	3.0		5Y 5/1	20.6
368			98.7	1.3		5GY 5/1	19.8
369		13.3	82.3	4.4		10YR 5/2	19.2
370		100.0				10YR 5/3	14.7
371			44.9	55.1		5GY 4/1	18.7
372			29.4	70.6		5GY 4/1	19.3
373			15.7	84.3		5Y 4/1	18.1
374			25.0	75.0		5GY 4/1	18.3
375			4.6	95.4		5GY 5/1	17.4
376			3.9	96.1		5Y 4/1	17.7
377		67.2	31.8	1.0		5Y 4/1	12.9
378		8.6	90.3	1.1		5Y 5/1	11.2
379		90.9	7.5	1.6		mixed	11.3
380		2.1	2.5	27.1	68.3	5Y 4/1	9.3
381		21.3	75.7	3.0		2.5Y 5/2	9.4
382		90.7	8.2	1.1		2.5Y 5/2	11.2
383		95.1	4.9			2.5Y 5/2	13.9
384		4.4	30.2	65.4		5GY 5/1	17.6
385		0.5	23.0	76.5		5GY 5/1	18.1
386			10.1	89.9		5GY 5/1	18.6
387			13.3	86.7		5GY 4/1	18.6
388			91.6	8.4		5GY 5/1	18.1
389			98.6	1.4		5Y 5/1	15.4
390			18.0	82.0		5GY 4/1	20.4
391			10.3	89.7		5GY 4/1	21.7
392			34.1	65.9		5GY 4/1	21.8
393		0.3	98.2	1.5		5GY 5/1	21.2
394		21.1	71.1	7.8		5GY 5/1	21.4
395		44.5	41.6	13.9		10YR 5/4	21.5
396		48.6	49.2	2.2		10YR 5/2	21.8
397		91.8	3.4	4.8		mixed	22.0
398	100.0					no sample	19.9
399		100.0				10YR 5/2	26.0
400			3.1	96.9		5GY 5/1	28.7
401			0.6	99.4		5G 5/1	28.8
402			0.6	99.4		5GY 5/1	28.9
403			0.3	99.7		5GY 5/1	29.2
404			0.2	89.8	10.0	5GY 5/1	29.2
405			0.6	99.4		5GY 5/1	29.2
406			0.5	99.5		5GY 5/1	30.2
407			0.3	99.7		5GY 5/1	30.0
408			0.3	99.7		5GY 5/1	30.3
409			0.8	99.2		5GY 5/1	30.0
410			0.5	99.5		5GY 5/1	30.4
411			0.3	99.7		5GY 5/1	30.9
412			0.6	99.4		5GY 5/1	29.8
413			0.7	99.3		5GY 5/1	30.6
414			0.3	99.7		5GY 5/1	29.9
415			1.8	98.2		5GY 5/1	29.9
416			0.5	99.5		5GY 5/1	29.4
417			0.3	99.7		5GY 4/1	29.9
418			0.9	99.1		5GY 4/1	29.0
419		0.8	1.7	97.5		5GY 5/1	29.1
420			0.3	99.7		5GY 5/1	29.1
421			0.9	99.1		5GY 5/1	28.8
422		0.3	2.5	94.2	3.0	5GY 5/1	26.7
423		1.1	10.8	88.1		5GY 4/1	26.0
424		100.0				mixed	22.3
425		100.0				mixed	21.1
426		24.5	73.7	1.8		2.5Y 3/2	21.5
427		0.1	98.8	1.1		2.5Y 3/2	21.4
428			15.7	84.3		2.5Y 3/2	22.3
429			16.3	83.7		5GY 4/1	22.4
430			5.6	94.4		5B 4/1	22.0
431			11.3	88.7		5B 4/1	21.1
432		1.3	45.5	53.2		5GY 4/1	20.0
433		1.5	36.4	62.1		5GY 4/1	20.0
434			7.4	92.6		5BG 4/1	19.8
435		1.4	12.3	86.3		5Y 4/1	19.0
436		13.4	48.8	37.8		5Y 5/1	18.4
437		30.0	67.7	2.3		5Y 5/1	16.9
438		67.9	32.1			2.5Y 6/2	13.4
439		10.0	90.0			2.5Y 4/2	11.4
440		67.6	29.6	2.8		2.5Y 5/2	10.5
441		4.6	62.1	33.3		10YR 4/2	10.6
442		7.9	28.7	63.4		2.5Y 4/2	7.6
443		91.9	7.3	0.8		N 4	9.3
444		8.3	91.1	0.6		2.5Y 4/2	11.7
445		8.3	90.0	1.7		10YR 4/2	13.3
446		79.2	20.8			10YR 4/1	13.7
447		48.0	52.0			10YR 4/2	16.9
448		19.8	78.3	1.9		10YR 4/1	18.4
449			1.3	98.7		5YR 4/1	19.6
450			6.1	93.9		5GY 4/1	20.1
451			4.0	82.5	13.5	5GY 4/1	21.7
452			9.2	90.8		5Y 2/1	21.2
453			3.9	96.1		5GY 4/1	22.1
454			2.3	97.7		5GY 4/1	22.9
455			2.3	97.7		5Y 4/1	23.3
456			4.3	92.1	3.6	5GY 4/1	24.2
457			7.2	92.8		5GY 5/1	24.5
458			14.7	85.3		5GY 4/1	25.2
459		10.6	16.6	72.8		5BG 4/1	26.0
460		15.9	25.5	58.6		5GY 4/1	25.9
461		31.7	61.0	7.3		10YR 4/1	25.5
462			5.4	94.6		5GY 4/1	29.5
463			1.8	98.2		5BG 4/1	29.5
464			1.7	98.3		5BG 4/1	29.9
465			0.6	99.4		5GY 5/1	29.9
466			1.5	98.5		5GY 5/1	29.8
467			0.5	99.5		5GY 5/1	29.9
468			0.8	96.3	2.9	5BG 4/1	30.7
469			1.0	84.9	14.1	5GY 5/1	30.6
470		0.3	0.9	98.8		5GY 4/1	30.7
471			0.2	99.8		5GY 5/1	30.8
472			0.3	99.7		5GY 5/1	30.6
473		0.3	0.6	99.1		5GY 5/1	31.2
474			0.4	94.7	4.9	5GY 5/1	31.1
475			0.9	94.8	4.3	5GY 5/1	30.8
476			0.5	96.0	3.5	5GY 4/1	30.8
477			0.3	95.9	3.8	N 4	30.8
478			0.8	94.4	4.8	5GY 4/1	30.8
479			0.2	99.8		5Y 4/1	30.8
480			0.3	99.7		5GY 4/1	30.4

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
481			0.3	99.7		5Y 3/1	30.4
482			0.3	99.7		5GY 4/1	30.6
483			6.8	93.2		5Y 4/1	31.1
484			0.7	89.6	9.7	5GY 4/1	30.0
485			0.3	88.2	11.5	5Y 4/1	29.8
486			1.2	98.8		5GY 4/1	28.9
487			0.8	99.2		5Y 4/1	27.0
488			2.8	97.2		5GY 4/1	26.4
489			11.9	88.1		5Y 4/1	26.1
490			11.3	88.7		5GY 4/1	25.4
491			5.8	94.2		5GY 5/1	24.8
492			5.4	94.6		5GY 4/1	24.6
493			2.5	97.5		5GY 5/1	24.4
494			0.3	96.7	3.0	5G 5/1	22.5
495			1.7	98.3		5GY 4/1	22.1
496			19.3	80.7		5GY 4/1	20.4
497			5.9	94.1		N 4	20.3
498			1.6	98.4		N 5	20.0
499		43.5	49.7	6.8		N 5	18.0
500		4.3	73.4	22.3		10YR 3/2	18.7
501		36.1	62.7	1.2		10YR 4/1	16.0
502		83.8	15.5	0.7		10YR 4/1	13.9
503		35.9	62.9	1.2		10YR 4/1	13.3
504		4.3	43.1	52.6		5GY 5/1	13.2
505		16.8	57.5	25.7		10YR 3/2	10.6
506		0.4	96.6	3.0		5Y 4/1	9.8
507		5.4	93.0	1.6		2.5Y 4/2	12.3
508		96.0	2.3	1.7		2.5Y 3/2	13.7
509			93.4	6.6		5Y 5/1	15.0
510		11.0	89.0			10YR 2/3	14.8
511	100.0					no sample	15.6
512		5.9	20.3	73.8		5Y 4/1	18.6
513			3.5	96.5		5Y 4/1	20.1
514			6.8	93.2		5Y 4/1	20.7
515		0.2	20.1	79.7		5GY 5/1	21.4
516			10.2	89.8		5Y 5/1	21.2
517			2.6	93.1	4.3	5Y 4/1	22.3
518			1.9	98.1		5Y 4/1	23.2
519				100.0		5Y 4/1	23.5
520			2.5	97.5		5Y 4/1	23.7
521			3.1	96.9		5GY 4/1	24.7
522			7.1	92.9		5GY 4/1	25.7
523		3.3	51.1	45.6		5GY 4/1	25.7
524		4.7	17.5	77.8		5GY 5/1	27.0
525			0.8	99.2		5GY 5/1	27.3
526			0.9	99.1		5Y 5/1	28.3
527			0.6	94.1	5.3	5Y 5/1	29.2
528			0.8	99.2		5GY 5/1	29.8
529			1.1	95.0	3.9	5Y 5/1	29.8
530			1.6	90.7	7.7	5GY 5/1	29.5
531			0.8	90.8	8.4	5GY 5/1	29.8
532			1.1	94.8	4.1	5Y 4/1	30.3
533			0.2	95.8	4.0	5Y 4/1	30.4
534			0.7	96.8	2.5	5GY 4/1	30.6
535			1.3	95.3	3.4	5Y 4/1	30.6
536			0.4	99.6		5GY 4/1	30.8
537			0.7	96.3	3.0	5GY 4/1	31.1
538			0.2	99.8		5GY 5/1	32.9
539			0.7	98.6	0.7	5GY 5/1	31.2
540			0.7	95.2	4.1	5GY 4/1	31.9
541			0.4	94.3	5.3	5GY 4/1	30.8
542			0.4	99.6		5GY 4/1	31.4
543		0.2	1.7	98.1		5GY 4/1	30.9
544			0.2	99.8		5Y 4/1	30.9
545			1.3	98.7		5Y 4/1	30.3
546			0.7	99.3		N 4	30.8
547			0.6	99.4		5GY 5/1	30.3
548			0.4	99.6		5Y 5/1	30.1
549			3.1	96.9		5GY 4/1	29.7
550			0.9	99.1		5GY 5/1	28.5
551			3.2	96.8		5GY 4/1	28.9
552			0.9	99.1		5Y 4/1	27.1
553			1.9	98.1		5Y 4/1	26.7
554			30.6	69.4		5GY 4/1	25.6
555			11.2	88.8		5Y 4/1	26.1
556			1.8	98.2		5Y 4/1	24.6
557			1.5	98.5		5GY 4/1	24.4
558			0.9	99.1		5Y 4/1	23.6
559			0.6	99.4		N 4	22.7
560			3.2	93.6	3.2	5Y 4/1	21.7
561			2.5	97.5		5Y 4/1	21.3
562			1.2	98.8		5Y 4/1	20.8
563			13.1	86.9		5Y 4/1	19.0
564		98.6	1.4			10YR 4/3	15.6
565		7.6	89.7	2.7		10YR 5/2	15.7
566		8.2	45.0	46.8		5GY 4/1	15.9
567		9.7	52.8	37.5		5Y 5/1	14.7
568			27.1	72.9		5Y 5/1	13.0
569		0.2	90.7	9.1		2.5Y 3/2	9.6
570			100.0			5Y 4/1	1.0
571		46.0	37.5	16.5		mixed	10.6
572		0.2	25.2	74.6		5Y 4/1	13.8
573			18.0	82.0		5Y 5/1	15.5
574		8.5	51.0	40.5		5Y 4/1	16.8
575			69.3	30.7		5Y 4/1	16.7
576		100.0				5Y 4/1	16.7
577			13.1	86.9		10YR 4/2	19.2
578			7.9	92.1		10YR 4/2	21.7
579				100.0		5Y 4/1	22.1
580			3.2	96.8		5Y 4/1	22.4
581			1.5	98.5		5GY 4/1	23.2
582			0.8	99.2		5Y 4/1	23.2
583			0.6	99.4		5GY 4/1	24.2
584			1.1	98.9		5Y 4/1	24.8
585			1.1	98.9		5Y 4/1	26.0
586		0.9	64.9	34.2		5Y 4/1	25.6
587			7.8	92.2		5Y 4/1	27.1
588			2.1	97.9		5Y 4/1	27.6
589		10.0	3.0	87.0		5GY 5/1	28.9
590			2.2	97.8		5Y 5/1	28.5
591			1.6	98.4		5GY 4/1	29.5
592			0.5	99.5		5Y 4/1	29.9
593				100.0		5GY 4/1	30.1
594			0.3	99.7		5GY 4/1	30.1
595			0.4	99.6		5GY 5/1	30.5
596		0.3	0.9	98.8		5Y 4/1	30.5
597			0.2	99.8		5GY 4/1	30.8
598			0.6	99.4		5Y 4/1	30.6
599			0.3	99.7		5Y 5/1	30.6
600			0.3	99.7		5GY 5/1	30.5
601			0.3	99.7		5GY 4/1	30.8
602			0.3	99.7		5GY 5/1	31.3
603				100.0		5GY 4/1	31.3
604				100.0		5Y 4/1	31.6

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
605			0.6	99.4		5GY 4/1	31.5
606				100.0		5GY 4/1	31.3
607			0.8	96.5	2.7	5GY 5/1	31.3
608			2.7	97.3		N 4	30.8
609			1.4	98.6		5GY 4/1	30.6
610			2.4	97.6		5GY 4/1	32.0
611			0.6	99.4		5GY 4/1	30.6
612			1.2	98.8		5Y 5/1	30.3
613			3.3	96.7		5GY 4/1	29.8
614			0.6	99.4		5GY 4/1	31.1
615				100.0		5GY 4/1	29.2
616			0.7	99.3		5GY 5/1	28.8
617				100.0		5GY 4/1	27.4
618		0.2	1.5	98.3		5Y 4/1	27.2
619			0.5	99.5		5GY 4/1	26.6
620			0.2	99.8		5Y 4/1	26.7
621			0.5	99.5		5Y 4/1	25.5
622			1.5	98.5		5Y 4/1	25.6
623				100.0		5Y 4/1	23.5
624				100.0		5Y 4/1	23.3
625			0.7	99.3		5Y 4/1	22.9
626			0.3	99.7		5GY 4/1	22.4
627			0.6	99.4		5Y 4/1	21.0
628			1.0	99.0		5GY 4/1	18.5
629		44.0	56.0			10YR 4/2	16.3
630		57.9	39.2	2.9		10YR 4/3	14.8
631		6.9	90.3	2.8		10YR 4/2	15.9
632			11.9	88.1		5Y 4/1	15.9
633		0.5	17.1	82.4		5Y 5/1	14.1
634			51.7	48.3		10YR 3/2	9.6
635			99.1	0.9		5Y 4/1	1.6
636		0.7	12.0	87.3		5GY 4/1	14.8
637		1.5	48.7	49.8		5Y 4/1	15.2
638		4.7	93.8	1.5		5Y 4/1	15.0
639		13.1	85.4	1.5		10YR 4/3	15.1
640	100.0					no sample	16.1
641			10.1	89.9		N 3	19.9
642			8.4	91.6		5GY 4/1	21.0
643			0.9	99.1		5GY 4/1	22.5
644			1.4	93.7	4.9	5GY 4/1	21.9
645			1.2	98.8		5Y 4/1	23.8
646		0.8	14.2	85.0		5BG 4/1	24.5
647			5.0	95.0		5GY 4/1	24.6
648			1.1	98.9		5GY 4/1	25.1
649			9.2	86.7	4.1	5GY 4/1	25.7
650			6.9	93.1		5GY 4/1	26.5
651			6.8	93.2		5GY 4/1	27.1
652		1.3	4.3	94.4		5BG 4/1	27.0
653		1.0	1.5	97.5		5GY 4/1	28.5
654			1.0	99.0		5G 4/1	29.2
655			1.2	96.1	2.7	5G 4/1	30.3
656				100.0		5GY 4/1	31.1
657			0.9	99.1		5GY 4/1	30.4
658				100.0		5Y 4/1	31.0
659			1.1	98.9		5Y 4/1	31.1
660			0.8	94.2	5.0	5Y 4/1	31.2
661				96.8	3.2	5Y 4/1	31.3
662			0.3	99.7		N 4	31.5
663				100.0		5Y 4/1	31.9
664				100.0		5Y 4/1	31.4
665			0.3	99.7		5GY 5/1	31.5
666				100.0		5Y 4/1	31.5
667			0.3	99.7		5Y 4/1	31.7
668			0.3	95.9	3.8	5Y 4/1	31.3
669			0.6	99.4		5Y 4/1	31.3
670			0.8	99.2		5GY 4/1	31.4
671			1.0	99.0		5GY 4/1	31.3
672			1.9	94.8	3.3	5BG 4/1	31.1
673			0.5	99.5		5BG 4/1	31.6
674			0.8	99.2		5Y 4/1	30.8
675			0.8	99.2		5GY 4/1	31.2
676			0.3	99.7		5GY 4/1	31.2
677			1.0	99.0		5GY 4/1	30.3
678			1.2	98.8		5GY 4/1	29.6
679			1.8	98.2		5GY 4/1	29.5
680			1.9	98.1		5GY 4/1	28.0
681		1.6	7.5	90.9		5GY 4/1	27.2
682			5.8	94.2		5GY 4/1	26.5
683			10.9	89.1		5GY 4/1	26.3
684			19.8	80.2		5G 4/1	25.1
685			28.0	72.0		5GY 4/1	24.7
686			2.7	97.3		5GY 4/1	24.7
687			3.4	96.6		5GY 4/1	23.3
688			2.4	97.6		5Y 4/1	22.7
689			2.9	97.1		5GY 4/1	22.4
690			2.6	97.4		5Y 4/1	21.4
691		3.0	13.5	83.5		2.5Y 3/2	17.1
692		41.7	58.3			7.5YR 7/2	17.0
693		14.5	84.4	1.1		5Y 4/1	15.9
694		27.9	72.1			5Y 4/1	15.2
695			35.7	64.3		5GY 4/1	16.2
696			25.1	74.9		5G 4/1	15.3
697			10.5	89.5		5Y 4/1	13.6
698			99.6	0.4		2.5Y 3/2	0.1
699			11.4	88.6		5Y 4/1	12.8
700			6.0	94.0		5GY 4/1	14.8
701		4.9	93.0	2.1		5Y 5/1	16.1
702		99.0	0.6	0.4		mixed	15.7
703		6.5	93.5			5Y 5/1	17.8
704			8.3	91.7		7.5YR 3/1	19.8
705			6.3	93.7		5GY 4/1	21.3
706			5.8	94.2		5GY 4/1	22.2
707			8.4	91.6		5GY 4/1	23.6
708			6.6	93.4		5GY 5/1	24.4
709		0.4	39.0	60.6		5Y 4/1	24.7
710		1.0	34.5	64.5		5GY 4/1	26.5
711			19.6	80.4		5GY 4/1	26.7
712		2.1	23.8	74.1		5GY 4/1	27.1
713			19.6	80.4		5Y 4/1	28.7
714			8.1	91.9		5Y 4/1	29.2
715			1.4	98.6		5B 4/1	29.0
716			1.3	98.7		5GY 4/1	29.8
717			2.1	97.9		5BG 4/1	30.2
718		0.5	3.5	96.0		5GY 4/1	31.1
719			1.9	98.1		5B 4/1	31.8
720			3.4	96.6		5GY 4/1	32.1
721			1.1	98.9		5G 4/1	31.8
722			2.6	97.4		5GY 4/1	31.4
723			2.6	97.4		5GY 4/1	31.7
724			1.8	94.8	3.4	5Y 4/1	32.0
725		0.6	2.7	96.7		N 3	31.7
726			1.8	94.0	4.2	5GY 4/1	31.3
727			0.4	99.6		5BG 4/1	31.8
728			0.2	85.0	14.8	5GY 4/1	31.3

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
729			0.5	99.5		*N* 4	31.9
730			3.7	96.3		5*GY* 4/1	31.2
731			15.2	84.8		5*GY* 5/1	31.2
732			7.3	92.7		5*GY* 5/1	31.7
733			1.9	98.1		5*GY* 5/1	31.9
734			1.9	98.1		*N* 4	31.7
735				100.0		5*GY* 5/1	32.0
736			13.9	86.1		5*GY* 5/1	31.9
737			3.4	96.6		5*B* 4/1	32.3
738		0.5	7.3	92.2		5*GY* 4/1	33.2
739			7.9	92.1		5*GY* 5/1	30.9
740			6.5	90.7	2.8	5*GY* 4/1	29.9
741			1.9	98.1		5*BG* 4/1	29.2
742			1.3	98.7		5*GY* 5/1	28.8
743			2.4	97.6		5*GY* 5/1	29.4
744			3.9	96.1		5*G* 4/1	24.4
745		0.6	35.3	64.1		5*BG* 4/1	27.2
746		6.2	24.9	68.9		5*GY* 4/1	28.0
747			6.3	93.7		5*GY* 4/1	27.2
748			20.6	66.3	13.1	5*BG* 4/1	25.3
749			8.3	91.7		5*GY* 5/1	24.9
750				100.0		5*GY* 5/1	22.9
751			6.0	94.0		5*BG* 4/1	21.8
752			6.0	94.0		5*GY* 4/1	20.9
753		93.1	3.5	3.4		10*YR* 4/3	18.9
754			15.9	84.1		5*GY* 5/1	17.0
755		100.0				mixed	13.5
756		32.1	65.8	2.1		5*Y* 4/1	14.0
757			99.1	0.9		5*Y* 5/1	7.6
758			99.5	0.5		2.5*Y* 4/2	5.6
759	100.0					no sample	6.0
760			4.5	95.5		5*Y* 6/1	21.8
761			14.3	85.7		5*GY* 5/1	23.7
762			3.3	96.7		5*G* 4/1	24.8
763		1.5	32.7	65.8		5*G* 4/1	26.2
764			7.4	92.6		*N* 4	29.2
765		1.1	50.4	47.1	1.4	5*GY* 5/1	27.4
766		0.5	11.8	87.7		*N* 5	25.9
767			4.0	96.0		*N* 4	29.2
768		100.0				10*YR* 7/6	27.9
769			2.6	97.4		*N* 4	29.3
770			5.2	94.8		*N* 5	29.6
771			13.6	86.4		*N* 5	31.2
772			3.5	96.5		*N* 3	32.1
773			1.6	98.4		5*Y* 4/1	32.7
774			11.1	88.9		*N* 5	31.7
775			21.8	78.2		*N* 4	30.2
776		14.8	9.4	75.8		5*GY* 4/1	32.2
777	100.0					no sample	13.2
778		100.0				10*YR* 6/2	23.7
779		0.2	7.8	92.0		5*BG* 4/1	31.3
780		0.3	26.2	73.5		5*GY* 5/1	30.7
781			11.3	88.7		5*GY* 5/1	31.5
782			3.1	96.9		*N* 5	31.2
783		0.3	5.0	94.7		5*Y* 4/1	32.7
784			42.0	58.0		*N* 5	32.2
785			34.0	66.0		*N* 5	31.2
786		50.0	40.9	9.1		2.5*Y* 6/2	30.2
787	100.0					no sample	14.2
788		100.0				mixed	10.4
789		1.3	59.4	39.3		5*Y* 5/1	27.5
790			42.5	57.5		5*Y* 4/1	29.6
791			9.2	90.8		*N* 5	31.8
792			7.6	92.4		5*GY* 5/1	30.2
793			5.0	95.0		5*Y* 5/1	23.1
794		0.3	38.2	61.5		5*Y* 5/1	30.7
795			22.2	77.8		5*Y* 4/1	30.5
796		0.3	7.2	92.5		5*GY* 5/1	30.5
797		81.4	17.0	1.6		10*YR* 4/1	28.8
798			4.8	95.2		5*GY* 5/1	27.6
799		1.8	35.8	62.4		5*GY* 5/1	34.1
800		12.1	36.2	51.7		5*Y* 4/1	32.8
801			2.6	97.4		5*GY* 4/1	30.8
802			2.7	97.3		5*GY* 5/1	26.4
803		0.3	44.5	55.2		5*Y* 5/1	25.1
804			5.4	94.6		5*Y* 5/1	22.0
805			18.5	81.5		5*Y* 5/1	19.9
806			84.3	15.7		5*Y* 5/1	13.2
807			7.4	92.6		5*Y* 4/1	26.2
808	100.0					no sample	19.7
809			4.4	95.6		5*Y* 4/1	33.7
810		77.9	9.4	12.7		5*Y* 5/1	35.2
811		19.7	80.3			10*YR* 3/2	19.2
812			0.6	99.4		5*Y* 4/1	30.7
813			56.3	43.7		5*Y* 4/1	28.7
814			15.4	84.6		*N* 4	30.4
815		1.1	18.0	80.9		5*Y* 4/1	31.7
816			5.9	94.1		5*GY* 5/1	30.7
817			52.5	47.5		*N* 5	26.7
818		100.0				2.5*Y* 3/2	12.7
819	100.0					no sample	6.0
820		16.5	75.7	7.8		5*GY* 5/1	23.9
821			28.7	71.3		5*Y* 5/1	31.7
822		2.8	55.9	41.3		5*GY* 4/1	32.7
823		100.0				7.5*YR* 3/2	31.7
824	100.0					no sample	27.7
825	100.0					no sample	23.8
826		7.7	33.2	44.7	14.4	5*GY* 5/1	32.2
827		10.5	31.1	51.7	6.7	5*GY* 5/1	33.6
828		0.2	58.2	26.0	15.6	10*YR* 5/2	31.5
829	100.0					no sample	19.8
830			11.1	83.6	5.3	5*Y* 3/1	30.6
831	100.0					no sample	6.9
832		4.8	93.3	1.9		10*YR* 3/2	30.4
833			79.9	13.0	7.1	10*YR* 3/2	29.0
834		2.0	24.8	62.6	10.6	5*GY* 3/1	35.4
835	100.0					no sample	3.9
836	100.0					no sample	16.9
837		16.2	39.4	23.5	20.9	10*YR* 4/2	29.4
838		2.3	11.4	63.8	22.5	5*Y* 4/1	31.6
839		14.0	82.0	4.0		10*YR* 4/2	25.3
840			8.6	75.1	16.3	5*GY* 4/1	28.1
841			47.9	50.3	1.8	*N* 4	15.6
842	100.0					no sample	10.2
843			38.1	61.9		*N* 4	15.0
844			33.0	67.0		5*GY* 5/1	15.8
845	100.0					no sample	22.0
846		60.1	39.4	0.5		5*GY* 4/1	23.7
847		38.5	54.3	7.2		5*Y* 4/1	25.9
848		27.8	60.6	11.6		5*Y* 4/1	25.6
849	100.0					no sample	32.8
850	100.0					no sample	14.4
851	100.0					no sample	21.6
852	100.0					no sample	12.6

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
853			73.1	26.9		5Y 4/1	18.0
854		15.9	26.2	55.8	2.1	N 4	34.7
855	100.0					no sample	23.2
856	100.0					no sample	10.9
857			100.0			10YR 5/2	9.8
858		2.1	97.7	0.2		5GY 4/1	27.3
859		19.2	80.1	0.7		10YR 4/2	16.0
860	100.0					no sample	32.8
861	100.0					no sample	30.6
862	100.0					no sample	27.2
863	100.0					no sample	16.7
864		39.2	15.4	27.3	18.1	N 5	34.0
865	100.0					no sample	15.3
866			27.5	48.8	23.7	N 6	23.5
867			82.2	17.8		5Y 4/1	6.9
868		8.0	86.6	5.4		5Y 4/1	22.2
869		0.8	98.8	0.4		5Y 4/1	4.4
870	100.0					no sample	32.5
871	100.0					no sample	13.1
872	100.0					no sample	13.5
873			4.8	66.6	28.6	N 4	25.2
874			6.4	88.9	4.7	N 4	24.7
875		3.2	47.5	31.9	17.4	10YR 5/2	27.2
876		24.6	63.6	11.8		5GY 5/1	28.4
877		59.5	40.0	0.5		5Y 4/1	24.4
878		0.8	12.8	70.7	15.7	5Y 4/1	29.1
879		77.8	21.8	0.4		10YR 3/2	20.8
880		7.7	91.9	0.4		10YR 4/2	19.0
881			29.0	55.4	15.6	5Y 4/1	18.6
882		0.7	45.1	49.9	4.3	N 5	16.2
883		7.7	90.9	1.4		5Y 4/1	14.4
884			99.3	0.7		10YR 5/2	+1.1
885			90.5	9.5		5Y 4/1	5.9
886	100.0					no sample	12.0
887	100.0					no sample	6.9
888			11.1	86.5	2.4	N 4	20.3
889		1.0	19.3	74.6	5.1	5Y 4/1	21.1
890		1.7	95.5	2.8		N 4	18.8
891	100.0					no sample	22.0
892		5.8	25.3	61.6	7.3	N 4	26.0
893		16.2	72.7	11.1		N 4	24.5
894		28.8	50.3	19.8	1.1	5GY 4/1	27.2
895		4.7	46.1	40.5	8.7	N 4	26.9
896		0.4	14.9	80.2	4.5	N 3.5	24.6
897			8.2	56.6	35.2	N 4	26.3
898			9.7	87.3	3.0	5Y 3/1	25.7
899	100.0					no sample	8.2
900		57.8	41.0	1.2		10YR 3/2	25.2
901	100.0					no sample	17.0
902		0.4	39.0	57.6	3.0	N 4	20.4
903	100.0					no sample	9.7
904			100.0			5Y 4/1	19.8
905		0.2	34.2	52.5	13.1	5Y 3/1	24.7
906		0.2	62.9	33.3	3.6	N 4	25.3
907		1.2	97.2	1.6		5Y 3/1	25.8
908		2.8	47.6	41.2	8.4	5Y 4/1	34.2
909	100.0					no sample	25.7
910		3.5	88.0	8.5		N 4	32.6
911		0.4	92.5	7.1		5Y 3/1	30.3
912		4.0	72.5	23.5		10YR 3/2	29.1
913		3.7	61.9	22.0	12.4	5Y 3/1	29.5
914		7.5	61.0	21.8	9.7	5Y 4/1	24.3
915			3.4	72.1	24.5	N 4	22.7
916		0.4	19.8	33.2	46.6	N 4	36.8
917	100.0					no sample	5.9
918	100.0					no sample	15.7
919			3.6	62.1	34.3	N 3	26.4
920			2.2	93.4	4.4	5Y 3/1	26.4
921			3.4	91.0	5.6	5Y 3/1	26.1
922			16.7	75.9	7.4	5Y 3/1	24.9
923			4.8	62.6	32.6	5Y 3/1	28.3
924		4.0	89.3	6.7		5Y 3/1	24.5
925		4.5	89.4	6.1		5Y 4/1	23.2
926		61.6	32.9	5.5		10YR 4/2	24.0
927		8.4	87.5	4.1		5Y 4/1	20.7
928		3.6	94.2	2.2		5Y 4/1	19.4
929		14.0	59.9	26.1		5Y 4/1	20.9
930			12.5	75.7	11.8	5GY 3/1	22.2
931			9.3	86.9	3.8	5Y 4/1	17.7
932			10.6	84.8	4.6	5GY 3/1	16.2
933			8.4	83.8	7.8	N 3	15.3
934			29.6	65.3	5.1	5Y 3/1	12.7
935			100.0			5Y 4/1	0.9
936		0.6	58.9	40.5		5Y 4/1	16.1
937		0.3	75.8	23.9		N 3	18.0
938			10.6	67.9	21.5	5Y 3/1	18.6
939		2.3	89.5	5.7	2.5	5GY 3/1	20.8
940			8.9	59.0	32.1	5Y 3/1	22.8
941		2.3	86.1	11.6		10YR 4/2	20.7
942		1.0	99.0			5Y 3/1	19.6
943		18.5	76.9	4.6		5Y 4/1	20.0
944		3.1	65.1	31.8		5Y 4/1	23.6
945		0.3	35.8	48.8	15.1	5Y 4/1	24.1
946		1.7	48.0	46.0	4.3	5Y 3/1	25.5
947		3.5	25.2	60.2	11.1	5Y 3/1	24.6
948			9.8	90.2		5Y 3/1	25.8
949		0.8	4.8	84.7	9.7	5Y 3/1	27.1
950			6.0	58.7	35.3	5GY 3/1	27.7
951			4.0	84.0	12.0	5Y 3/1	27.9
952			4.1	42.4	53.5	5Y 3/1	28.7
953	100.0					no sample	26.7
954		2.5	62.5	35.0		5Y 3/1	17.4
955		0.5	64.5	35.0		5Y 4/1	26.7
956		0.2	29.7	59.6	10.5	5GY 3/1	23.5
957		20.0	80.0			10YR 4/2	22.7
958			7.5	43.0	49.5	N 5	39.6
959		0.4	3.8	38.4	57.4	5Y 3/1	35.4
960		3.8	20.3	42.8	33.1	5Y 3/1	32.8
961		2.7	26.1	43.2	28.0	5Y 3/1	32.6
962		0.8	3.5	46.2	49.5	5GY 3/1	36.1
963		1.8	5.0	44.7	48.5	5Y 3/1	41.2
964	100.0					no sample	31.7
965		3.8	14.0	52.7	29.5	5GY 3/1	28.9
966		0.3	28.2	34.5	37.0	5Y 3/1	29.3
967		0.4	12.5	52.1	35.0	5GY 3/1	29.4
968		2.9	5.3	56.2	35.6	5Y 3/1	29.9
969		1.2	8.3	63.3	27.2	5GY 3/1	28.8
970			5.4	82.1	12.5	5GY 3/1	28.9
971			4.2	90.5	5.3	5Y 3/1	29.9
972			2.3	65.4	32.3	5Y 3/1	28.7
973			11.8	76.4	11.8	5Y 3/1	26.4
974			24.0	76.0		5Y 3/1	25.7
975			10.9	86.0	3.1	5Y 3/1	26.0
976		6.8	35.9	39.3	18.0	5Y 3/1	24.7

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
977		0.9	39.3	36.8	23.0	10*YR* 4/2	23.6
978	100.0					no sample	18.7
979		10.4	88.8		0.8	5*Y* 4/1	19.7
980		0.7	26.4	54.9	18.0	10*YR* 5/2	23.0
981		2.1	97.5	0.4		10*YR* 3/2	19.8
982		2.6	55.6	34.9	6.9	5*GY* 5/1	22.8
983			68.4	25.0	6.6	*N* 3	21.1
984		10.8	85.1	4.1		5*GY* 5/1	20.0
985		4.1	52.5	43.4		5*YR* 4/6	17.8
986		16.7	71.3	12.0		*N* 1	17.5
987		2.9	94.0	3.1		10*YR* 3/2	23.1
988		0.8	74.7	22.9	1.6	5*GY* 5/1	23.0
989		1.6	55.4	37.2	5.8	*N* 4	23.1
990		2.0	96.7	1.3		5*Y* 5/1	20.8
991			100.0			5*YR* 4/2	20.6
992		9.9	90.1			5*Y* 5/1	20.1
993		100.0				mixed	19.4
994		18.2	81.8			5*Y* 5/1	22.4
995	100.0					no sample	22.0
996			18.5	57.3	24.2	5*GY* 5/1	26.3
997			13.3	77.0	9.7	*N* 3	26.9
998			5.3	84.0	10.7	5*GY* 5/1	27.8
999			3.3	92.9	3.8	*N* 3	30.7
1000		0.5	11.4	78.7	9.4	*N* 3	31.0
1001		1.3	15.1	76.9	6.7	5*GY* 5/1	31.3
1002		1.8	16.0	56.4	25.8	5*GY* 5/1	30.9
1003		0.3	13.8	64.5	21.4	5*GY* 6/1	30.1
1004		0.7	31.4	59.6	8.3	*N* 4	30.4
1005		0.6	47.7	26.3	25.4	5*GY* 5/1	30.3
1006		1.0	37.7	48.8	12.5	5*GY* 5/1	32.3
1007		0.3	15.0	59.3	25.4	5*GY* 5/1	41.0
1008		7.8	13.6	57.2	21.4	5*GY* 5/1	38.2
1009		0.4	11.0	79.4	9.2	5*GY* 5/1	35.0
1010		10.5	40.3	29.0	20.2	5*GY* 5/1	34.7
1011		3.5	14.1	32.4	50.0	5*Y* 5/1	35.5
1012		0.5	7.7	40.7	51.1	5*GY* 5/1	36.3
1013		0.4	19.9	48.7	31.0	5*GY* 5/1	34.9
1014		5.5	44.1	27.4	23.0	5*GY* 6/1	31.5
1015		0.6	45.5	40.5	13.4	5*GY* 5/1	30.8
1016			23.3	49.3	27.4	5*GY* 6/1	31.6
1017		3.0	37.0	33.7	26.3	5*GY* 5/1	31.2
1018			17.2	66.1	16.7	5*GY* 5/1	32.7
1019			15.3	54.1	30.6	5*GY* 6/1	32.6
1020			8.6	57.3	34.1	*N* 3	32.0
1021			2.8	86.1	11.1	5*GY* 5/1	29.9
1022			3.2	71.8	25.0	5*GY* 5/1	27.7
1023			1.8	75.1	23.1	5*GY* 5/1	28.0
1024			2.8	74.8	22.4	5*GY* 5/1	26.2
1025	100.0					no sample	20.1
1026		13.5	86.5			10*YR* 5/2	20.5
1027		22.9	77.1			10*YR* 5/2	21.0
1028		6.6	70.5	18.4	4.5	5*GY* 5/1	22.4
1029		1.3	95.4	3.3		5*Y* 5/1	21.6
1030		1.4	60.5	28.1	10.0	5*GY* 5/1	23.7
1031		2.6	32.6	53.7	11.1	5*GY* 5/1	25.2
1032		2.7	45.2	52.1		5*GY* 6/1	25.5
1033			94.7	5.3		5*GY* 4/1	19.1
1034		0.4	21.2	65.4	13.0	10*YR* 5/2	24.7
1035			10.0	85.0	5.0	5*GY* 5/1	27.0
1036		1.2	12.2	64.2	22.4	5*GY* 5/1	26.3
1037		1.3	45.8	42.5	10.4	5*GY* 6/1	24.4
1038		1.2	60.8	33.0	5.0	5*GY* 5/1	23.4
1039		7.2	64.8	26.5	1.5	10*YR* 5/2	23.6
1040		14.6	85.4			5*YR* 4/2	20.1
1041		26.1	71.7	2.2		5*YR* 4/2	19.1
1042	100.0					no sample	20.2
1043			9.5	75.3	15.2	5*GY* 5/1	24.7
1044			2.6	97.4		5*GY* 5/1	28.9
1045			1.5	79.2	19.3	5*GY* 5/1	28.7
1046			1.6	86.8	11.6	5*GY* 5/1	30.5
1047		1.6	27.8	70.6		5*GY* 5/1	33.3
1048			12.3	84.6	3.1	5*GY* 5/1	34.8
1049		1.1	32.2	59.8	6.9	5*GY* 5/1	33.7
1050		2.8	47.1	48.5	1.6	5*GY* 5/1	31.7
1051		0.6	47.3	44.9	7.2	5*GY* 5/1	31.1
1052		4.9	52.7	29.4	13.0	5*GY* 5/1	31.6
1053		3.0	38.2	44.2	14.6	5*GY* 6/1	33.5
1054		2.3	34.4	43.1	20.2	5*GY* 6/1	35.4
1055		8.0	43.8	26.6	21.6	5*GY* 5/1	35.9
1056		2.7	24.8	39.6	32.9	5*GY* 6/1	35.5
1057		2.1	38.9	34.5	24.5	5*GY* 5/1	35.6
1058		5.3	26.9	35.4	32.4	5*GY* 5/1	35.3
1059		6.4	27.1	60.1	6.4	5*GY* 5/1	34.5
1060		0.6	48.6	37.6	13.2	5*GY* 5/1	32.9
1061		1.2	63.2	22.4	13.2	10*YR* 5/2	31.3
1062		0.4	53.7	44.5	1.4	5*GY* 5/1	31.5
1063		12.9	39.9	45.8	1.4	5*Y* 5/1	32.3
1064		1.8	33.0	53.8	11.4	5*Y* 5/1	36.5
1065			21.2	68.4	10.4	5*GY* 5/1	34.7
1066		1.3	26.9	63.8	8.0	5*GY* 5/1	33.7
1067		1.5	3.3	73.2	22.0	*N* 3	32.6
1068			3.4	91.9	4.7	5*GY* 5/1	30.4
1069		6.4	93.6			5*YR* 5/1	20.2
1070		8.0	84.6	7.4		5*YR* 4/2	19.2
1071		0.4	99.6			5*YR* 4/6	20.3
1072		3.1	53.3	25.8	17.8	5*YR* 4/2	23.6
1073		3.3	57.4	37.8	1.5	5*GY* 5/1	23.4
1074		0.9	52.2	35.0	11.9	5*GY* 5/1	25.0
1075			21.9	78.1		5*GY* 5/1	28.8
1076			4.5	92.5	3.0	5*Y* 5/1	30.0
1077			10.8	86.6	2.6	5*GY* 5/1	29.0
1078			100.0			10*YR* 5/2	3.3
1079			4.9	95.1		5*GY* 5/1	31.3
1080		3.6	29.8	66.6		5*GY* 5/1	22.1
1081			49.1	42.5	8.4	*N* 4	28.9
1082		7.1	86.8	6.1		5*Y* 4/1	25.1
1083		3.2	68.6	28.2		*N* 4	23.5
1084		2.3	87.2	10.5		*N* 5	23.5
1085		11.7	88.3			5*Y* 5/1	20.5
1086	100.0					no sample	9.6
1087			3.6	83.0	13.4	*N* 2	34.5
1088		3.0	10.4	77.6	9.0	*N* 4	37.3
1089		1.0	16.1	74.1	8.8	5*GY* 5/1	37.6
1090		9.3	33.5	44.2	13.0	5*GY* 5/1	40.3
1091		0.6	71.6	27.8		5*Y* 5/1	33.8
1092		1.3	86.5	12.2		5*GY* 5/1	31.8
1093		2.2	62.9	23.3	11.6	*N* 5	31.6
1094		0.7	43.2	56.1		*N* 4	34.0
1095		1.6	56.6	28.8	13.0	5*Y* 5/1	34.5
1096		0.3	58.2	32.3	9.2	10*YR* 5/2	33.8
1097		0.8	63.4	25.7	10.1	*N* 3	33.9
1098		5.0	58.5	36.5		*N* 4	32.3
1099		1.6	84.8	13.6		10*YR* 5/2	31.4
1100		1.7	84.5	13.8		5*GY* 5/1	32.3

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
1101							
1102							
1103							
1104							
1105		7.9	28.9	39.2	24.0	5Y 5/1	42.9
1106			5.9	86.0	8.1	5Y 5/1	40.6
1107			4.1	83.1	12.8	5Y 5/1	35.7
1108	100.0					no sample	3.1
1109		1.5	98.5			10YR 5/2	19.5
1110		2.8	97.2			5Y 4/1	22.9
1111		5.8	68.6	15.3	10.3	5Y 4/1	23.5
1112		4.5	95.5			5Y 5/1	27.9
1113			70.2	29.8		N 4	30.7
1114		2.8	60.6	30.0	6.6	N 4	33.1
1115			7.9	90.3	1.8	5Y 5/1	33.8
1116	100.0					no sample	22.0
1117			38.9	61.1		5Y 4/1	16.4
1118			100.0			5Y 5/1	13.7
1119			84.0	16.0		10YR 5/2	13.2
1120			47.7	52.3		10YR 5/2	10.1
1121			100.0			10YR 5/2	0.7
1122			100.0			10YR 5/2	6.0
1123			100.0			10YR 5/2	2.6
1124			100.0			5Y 5/1	8.1
1125			100.0			5Y 5/1	14.4
1126			100.0			5Y 5/1	15.6
1127			40.4	56.0	3.6	5Y 5/1	21.5
1128		0.3	22.1	77.6		5Y 5/1	24.3
1129			5.1	79.2	15.7	5G 5/1	31.9
1130			15.0	85.0		5B 4/1	34.5
1131			50.1	49.9		5GY 5/1	33.6
1132		0.9	95.2	3.9		5B 4/1	32.3
1133		12.9	87.1			5Y 4/1	29.0
1134		0.3	98.4	1.3		5B 4/1	23.8
1135	100.0					no sample	12.8
1136			100.0			10YR 5/2	+0.3
1137		1.2	98.8			5Y 4/1	25.8
1138			15.8	59.8	24.4	5GY 6/1	36.2
1139		0.7	6.7	68.1	24.5	5GY 5/1	43.4
1140			4.3	88.9	6.8	N 4	48.0
1141		4.2	26.3	67.1	2.4	5GY 5/1	49.2
1142		1.5	92.4	6.1		5Y 5/1	31.6
1143			100.0			5Y 5/1	30.6
1144		7.5	92.5			5Y 5/1	28.5
1145		10.3	89.7			5YR 4/6	28.3
1146			100.0			5GY 5/1	29.8
1147			100.0			5Y 5/1	28.3
1148		68.8	31.2			10YR 5/2	27.3
1149		93.6	6.4			5YR 5/6	30.4
1150	100.0					no sample	3.6
1151		1.0	99.0			10YR 5/2	20.4
1152			11.5	70.2	18.3	5B 6/1	48.8
1153			6.0	52.7	41.3	5Y 5/1	50.6
1154		63.0	37.0			5Y 5/1	40.0
1155		1.4	31.3	49.9	17.4	5GY 5/1	39.3
1156		9.9	90.1			5Y 5/1	22.9
1157			100.0			5Y 5/1	+0.3
1158	100.0					no sample	1.7
1159		27.1	72.9			5YR 3/6	19.5
1160			96.0	4.0		5GY 5/1	28.3
1161		0.5	66.3	27.4	5.8	5Y 5/1	33.8
1162			36.1	56.9	7.0	5Y 5/1	35.0
1163		41.0	10.1	46.1	2.8	N 3	34.6
1164			3.0	94.8	2.2	5GY 5/1	33.5
1165			8.1	90.3	1.6	5Y 5/1	28.9
1166			21.7	78.3		5Y 5/1	26.4
1167			97.3	2.7		5Y 5/1	22.3
1168			34.4	60.1	5.5	N 4	19.9
1169			100.0			5Y 5/1	13.3
1170			64.0	34.7	1.3	5Y 5/1	14.4
1171			100.0			5Y 5/1	3.5
1172			100.0			5Y 5/1	18.0
1173			65.7	31.8	2.5	5Y 4/1	18.2
1174			14.0	84.4	1.6	5B 4/1	24.2
1175			14.6	83.9	1.5	5Y 4/1	26.9
1176			18.8	75.2	6.0	5B 4/1	30.2
1177		0.2	43.5	47.4	8.9	N 3	31.5
1178			6.7	90.5	2.8	N 4	34.6
1179			8.4	89.4	2.2	5GY 5/1	35.9
1180			8.3	88.1	3.6	5Y 4/1	36.4
1181			11.7	83.6	4.7	N 4	36.3
1182		0.2	46.8	51.2	1.8	N 4	32.3
1183	100.0					no sample	25.8
1184	100.0					no sample	7.5
1185	100.0					no sample	6.0
1186	100.0					no sample	11.4
1187		4.8	22.8	65.0	7.4	5B 4/1	38.1
1188		38.6	61.4			5Y 4/1	42.1
1189		4.0	14.0	60.2	21.8	N 4	48.6
1190			6.2	73.7	20.1	N 4	48.5
1191			56.9	43.1		N 2	35.6
1192	100.0					no sample	1.9
1193			12.6	84.3	3.1	5Y 5/1	34.2
1194	100.0					5Y 4/1	31.9
1195		21.0	79.0			5Y 5/1	31.6
1196	100.0					no sample	33.5
1197	100.0					no sample	20.7
1198			37.3	54.4	8.3	N 4	36.7
1199		62.8	37.2			5YR 4/6	32.7
1200			3.6	75.2	21.2	N 4	47.1
1201			100.0			5Y 5/1	31.1
1202	100.0					no sample	34.9
1203	100.0					no sample	23.8
1204	100.0					no sample	17.4
1205	100.0					no sample	19.1
1206	100.0					no sample	9.9
1207	100.0					no sample	27.5
1208			5.4	85.3	9.3	5Y 5/1	33.3
1209			32.0	61.1	6.9	5Y 5/1	33.3
1210			5.8	74.7	19.5	N 4	35.9
1211			2.5	61.4	36.1	N 4	37.8
1212			2.0	95.6	2.4	N 4	37.9
1213		11.5	12.0	74.3	2.2	N 4	35.9
1214		3.4	52.8	43.8		5Y 5/1	31.2
1215			29.2	70.8		N 3	32.5
1216		3.2	39.0	57.8		5Y 5/1	31.8
1217			16.6	83.4		N 4	29.0
1218			15.2	84.8		5Y 5/1	26.6
1219			51.0	43.4	5.6	N 4	22.4
1220			71.9	28.1		5Y 5/1	18.9
1221			100.0			5Y 5/1	15.5
1222			100.0			5Y 5/1	8.6
1223			100.0			10YR 5/2	2.6
1224			100.0			10YR 5/2	2.2

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
1225			100.0			5Y 5/1	8.9
1226			37.3	62.7		5Y 4/1	19.6
1227			58.7	41.3		5Y 4/1	20.5
1228		0.9	27.4	63.1	8.6	5Y 5/1	25.5
1229			66.3	23.7		5Y 5/1	26.9
1230			35.7	62.9	1.4	5Y 5/1	28.7
1231		4.9	48.4	45.5	1.2	N 4	30.9
1232			7.9	92.1		N 4	33.1
1233			5.4	91.7	2.9	N 4	34.4
1234		2.9	10.5	45.8	40.8	5YR 6/1	34.1
1235		6.4	56.5	36.1	1.0	5Y 5/1	37.5
1236			18.4	81.6		N 3	36.6
1237			5.9	94.1		N 4	34.4
1238			7.6	92.4		5Y 5/1	33.5
1239			6.6	93.4		5Y 5/1	35.0
1240		1.2	15.5	74.0	9.3	N 4	38.3
1241	100.0					no sample	31.0
1242	100.0					no sample	19.6
1243	100.0					no sample	28.3
1244		9.6	14.3	72.8	3.3	5Y 4/1	40.8
1245		5.1	94.9			10YR 3/2	38.9
1246		53.1	46.9			5YR 4/6	29.9
1247	100.0					no sample	31.6
1248	100.0					no sample	11.0
1249		1.7	41.5	55.8	1.0	5GY 5/1	47.1
1250			30.8	69.2		N 4	38.5
1251		1.2	59.9	38.9		5Y 5/1	35.3
1252			76.5	21.1	2.4	5Y 5/1	34.1
1253		1.3	62.4	32.1	4.2	5Y 4/1	32.7
1254			81.4	18.6		N 4	33.2
1255			68.3	31.7		N 4	34.9
1256		0.5	45.6	50.7	3.2	5Y 5/1	35.7
1257			17.2	81.0	1.8	5Y 5/1	42.7
1258		78.8	21.2			5YR 2/4	44.7
1259	100.0					no sample	2.7
1260		1.4	98.6			5YR 5/4	37.0
1261	100.0					no sample	33.9
1262		5.3	78.4	16.3		5Y 5/1	41.5
1263		0.7	37.3	60.2	1.8	N 4	41.6
1264		0.8	84.2	15.0		N 3	39.4
1265		0.4	41.8	56.3	1.5	N 4	38.7
1266			14.2	66.9	18.9	N 4	40.1
1267			3.2	71.8	25.0	5Y 5/1	39.6
1268			6.3	71.3	22.4	N 4	38.2
1269			7.1	79.0	13.9	5Y 5/1	37.2
1270			3.0	74.0	23.0	N 3	37.9
1271		1.5	6.1	92.4		N 3	38.9
1272			3.1	94.8	2.1	N 4	37.9
1273			5.3	94.7		5Y 5/1	34.7
1274			11.6	86.2	2.2	5Y 5/1	34.1
1275			4.9	95.1		N 4	35.1
1276		2.8	31.6	65.6		N 5	33.0
1277		0.5	35.4	64.1		N 3	32.1
1278			19.3	80.7		N 4	29.7
1279			61.7	38.3		5Y 5/1	23.9
1280			23.3	71.1	5.6	N 3	25.1
1281			22.9	77.1		N 3	24.7
1282			27.0	73.0		5Y 5/1	20.7
1283			45.7	54.3		5Y 4/1	19.7
1284			100.0			5YR 5/2	8.3
1285			100.0			5Y 5/1	11.4
1286			100.0			5YR 4/2	14.4
1287			22.1	77.9		N 4	24.7
1288		0.3	26.7	73.0		5Y 4/1	24.7
1289			18.6	81.4		N 3	27.3
1290			13.0	87.0		N 4	28.9
1291			32.3	67.7		N 4	27.5
1292			11.9	85.9	2.2	N 3	32.7
1293			6.2	93.8		N 4	33.6
1294		23.3	57.9	18.8		N 5	34.2
1295		0.8	2.4	96.8		N 4	36.9
1296			5.4	88.8	5.8	5GY 5/1	38.1
1297			11.4	88.6		5Y 5/1	37.7
1298			2.5	97.5		5GY 5/1	39.7
1299			2.6	97.4		5B 4/1	39.5
1300			6.1	91.4	2.5	N 3	39.2
1301			8.3	86.0	5.7	N 4	39.6
1302			4.2	95.8		5Y 4/1	40.5
1303		0.3	11.5	86.6	1.6	5GY 5/1	41.7
1304			12.4	85.6	2.0	5GY 5/1	39.7
1305			6.7	93.3		5Y 5/1	39.4
1306			24.1	75.9		N 4	40.0
1307			67.5	31.5	1.0	5GY 5/1	39.4
1308		0.9	14.1	84.1	0.9	5GY 5/1	41.4
1309			100.0			5YR 4/2	40.6
1310			2.9	87.9	9.2	N 3	45.5
1311	100.0					no sample	3.2
1312			6.8	86.1	7.1	N 4	48.2
1313			12.8	87.2		N 4	42.2
1314			38.8	59.8	1.4	5Y 5/1	37.5
1315		1.0	46.8	52.2		N 4	38.4
1316			67.7	32.3		N 4	32.7
1317		0.1	61.7	38.2		5Y 5/1	33.7
1318			29.2	70.8		N 4	36.0
1319		0.4	18.7	80.9		5Y 5/1	38.7
1320			7.2	92.8		N 4	42.9
1321			7.8	65.6	26.6	N 4	44.2
1322			4.1	73.6	22.3	5Y 5/1	46.0
1323			2.5	93.7	3.8	5Y 5/1	45.6
1324			2.3	72.4	25.3	5Y 5/1	53.9
1325			2.2	59.2	38.6	5Y 5/1	44.0
1326			2.9	74.1	23.0	5Y 5/1	42.0
1327			6.4	90.6	3.0	N 4	41.3
1328			8.2	63.2	28.6	5Y 5/1	40.5
1329			7.4	92.6		N 4	40.5
1330			12.9	75.9	11.2	5Y 5/1	41.0
1331			5.3	94.7		5Y 5/1	41.0
1332		0.6	42.8	56.6		N 4	40.1
1333		0.2	16.2	81.6	2.0	5Y 5/1	40.4
1334			1.9	86.8	11.3	5Y 5/1	40.1
1335			2.5	67.7	29.8	5GY 5/1	40.7
1336			19.0	76.3	4.7	5Y 5/1	40.0
1337			13.7	76.8	9.5	5Y 5/1	38.7
1338			1.8	62.4	35.8	N 4	38.5
1339			3.3	69.9	26.8	5Y 5/1	36.5
1340			100.0			5Y 5/1	32.3
1341			7.8	91.4	0.8	5GY 5/1	32.4
1342			22.4	76.4	1.2	N 4	30.1
1343			14.0	66.8	19.2	5Y 5/1	31.4
1344			13.2	86.8		5Y 5/1	29.5
1345		0.1	25.6	74.3		N 4	26.6
1346			22.4	77.6		N 5	26.8
1347			7.7	92.3		N 4	22.2

TABLE A.—*Analyses of surface sediment samples*—Continued

Sample number	Percent particle size					Munsell color code	Water depth (feet)
	Bedrock	Gravel	Sand	Silt	Clay		
1348			20.0	78.3	1.7	5Y 5/1	22.2
1349			100.0			10YR 5/2	11.2
1350			100.0			5Y 4/1	10.6
1351			16.2	82.2	1.6	5Y 5/1	21.6
1352			17.0	81.4	1.6	5GY 4/1	25.7
1353		0.3	24.5	72.0	3.2	5Y 5/1	25.7
1354			13.4	77.6	9.0	5Y 5/1	28.1
1355		0.2	9.1	90.7		N 4	30.7
1356			2.4	66.5	31.1	5Y 5/1	32.9
1357			1.5	98.5		5Y 5/1	34.2
1358			10.0	90.0		N 3	32.9
1359			4.9	95.1		N 4	34.5
1360			3.2	96.8		5Y 5/1	37.1
1361			2.4	97.6		5GY 5/1	38.3
1362			1.8	98.2		5Y 5/1	40.0
1363			0.8	58.4	40.8	N 4	40.7
1364			1.0	97.1	1.9	5GY 5/1	41.2
1365			2.4	70.6	27.0	5Y 5/1	41.7
1366			8.4	89.4	2.2	5GY 6/1	41.5
1367		0.5	18.6	79.8	1.1	5Y 5/1	40.7
1368			6.1	64.3	29.6	5Y 5/1	41.0
1369		0.4	9.8	64.7	25.1	5Y 6/1	41.5
1370		0.2	15.7	84.1		N 4	40.9
1371		0.2	35.1	54.8	9.9	5Y 5/1	41.4
1372		0.2	51.3	39.4	9.1	5GY 4/1	41.6
1373			12.6	87.4		5Y 5/1	42.4
1374			2.0	87.1	10.9	5Y 5/1	43.3
1375			4.5	78.0	17.5	5Y 5/1	44.5
1376			3.2	67.0	29.8	5Y 5/1	45.8
1377			2.9	71.3	25.8	5Y 5/1	44.5
1378			4.3	59.8	35.9	5Y 5/1	43.0
1379			9.6	80.8	9.6	5Y 5/1	40.9
1380			9.6	78.0	12.4	5Y 5/1	41.3
1381			21.1	70.5	8.4	5Y 5/1	38.9
1382			18.2	81.8		N 4	36.9
1383			64.8	32.9	2.3	N 4	34.8

TABLE B.—*Grain-size distribution of sand and gravel samples*

Sample number	Phi median (Mdϕ) grain diameter	Sorting coefficient (So)
2	−1.50	2.88
3	<−2.25	--
4	1.6	1.86
5	<−2.25	--
6	1.9	1.47
7	<−2.25	--
8	<−2.25	--
11	1.7	1.74
12	0.2	>4.7
14	1.7	1.80
26	0.6	2.54
27	2.6	2.30
28	<−2.25	--
29	<−2.25	--
30	−0.6	>4.10
31	<−2.25	--
32	0.2	>4.10
33	<−2.25	--
34	<−2.25	--
35	<−2.25	--
36	0.3	3.81
37	1.3	1.80
38	3.1	1.47
39	1.8	2.46
40	−0.5	>2.99
41	−0.2	>4.10
42	<−2.25	--
43	0.5	3.72
44	<−2.25	--
45	<−2.25	--
46	<−2.25	--
47	1.3	>4.40
48	<−2.25	--
49	1.1	>3.53
50	0.4	1.27
55	2.1	>5.70
65	2.8	2.63
66	0.3	1.32
67	1.4	1.32
68	1.2	>4.40
69	<−2.25	--
70	<−2.25	--
71	−1.0	>4.15
72	<−2.25	--
73	<−2.25	--
74	1.5	1.86
75	<−2.25	--
76	2.5	1.15
77	2.7	1.19
78	<−2.25	>2.88
79	<−2.25	--
80	<−2.25	--
81	1.2	2.38
82	1.6	1.86
83	1.7	3.60
84	<−2.25	--
85	<−2.25	>4.10
86	2.2	1.57
87	2.9	1.15
105	3.3	1.15
108	<−2.25	--
110	1.6	4.70
111	<−2.25	--
112	−0.6	3.60
113	0.0	>4.10
114	<−2.25	>2.99
115	2.1	1.47
116	1.1	3.37
117	1.7	1.86
119	<−2.25	--
120	1.6	1.93
121	<−2.25	--
122	<−2.25	--
123	<−2.25	--
124	<−2.25	--
125	1.6	3.37
126	<−2.25	--
129	3.3	1.19
153	<−2.25	3.95
155	<−2.25	3.95
156	1.7	1.23
157	0.8	>4.15
158	1.8	1.62
159	1.9	1.42
160	2.6	1.23
161	2.3	1.52
162	2.4	1.15
163	2.3	1.23
164	1.7	1.42
165	1.8	1.52
169	1.9	1.57
200	<−2.25	>2.35
201	<−2.25	--
202	1.9	1.27
203	2.2	1.19
204	2.8	1.11
205	3.0	1.27
206	3.4	1.47
207	2.2	1.27
208	3.6	1.52
209	3.0	1.23
210	0.6	4.1
211	3.1	1.32
212	2.8	1.19
213	2.9	1.23
214	2.1	1.32
215	2.1	1.57
216	2.4	1.19
217	2.0	1.23
218	<−2.25	--
222	<−2.25	--
223	−1.30	2.52
252	<−2.25	2.99
254	2.2	1.23
255	0.5	>4.8
256	1.9	1.32
257	2.4	1.15
258	3.1	1.27
259	2.7	1.32
260	3.2	1.27
261	3.3	1.27
262	0.0	4.7
263	1.5	3.14
265	3.2	1.27
266	3.0	1.27
267	2.9	1.23
268	3.2	1.32
269	3.0	1.15
270	2.3	1.11
271	2.0	1.19
272	<−2.25	>3.09
275	<−2.25	3.37
278	1.5	1.74
280	1.6	1.86
302	1.7	6.2
307	−2.0	>3.81
308	2.3	1.27
309	2.2	1.27
310	2.1	1.23
311	2.4	1.08
312	3.1	1.23
314	3.1	1.23
315	3.2	1.23
316	3.4	1.23
318	3.3	1.42
319	3.0	1.32
320	2.9	1.19
321	<−2.25	--
324	3.3	1.27
325	3.4	1.37
326	3.4	1.23
328	2.4	1.19
363	1.8	1.47
364	<−2.25	2.27
365	1.6	1.80
366	1.9	1.42
367	<−2.25	--
368	2.0	1.37
369	1.5	1.93
371	3.4	1.15
372	3.1	1.19
374	3.3	1.37
377	<−2.25	2.88
378	1.7	1.68
379	<−2.25	--
381	1.5	2.54
382	<−2.25	--
384	2.0	1.68
388	3.0	1.19
389	3.0	1.19
392	3.1	1.23
393	2.3	1.37
394	1.7	2.54
395	−0.7	>4.1
396	−0.3	>4.1
397	<−2.25	--
425	<−2.25	--
426	1.9	2.46
427	2.4	1.27
432	3.4	1.42
433	3.4	1.11
436	1.6	1.38
437	1.3	4.35
438	<−2.25	2.99
439	1.8	1.68
440	<−2.25	3.43

TABLE B.—*Grain-size distribution of sand and gravel samples*—Continued

Sample number	Phi median (Md_ϕ) grain diameter	Sorting coefficient (So)
441	1.9	1.52
442	1.9	3.14
443	<–2.25	--
444	1.7	1.62
445	1.7	1.86
446	<–2.25	--
447	0.0	3.94
448	1.4	2.07
460	<–2.25	--
461	0.3	3.21
499	–0.2	3.94
500	1.4	1.57
501	0.3	3.56
502	<–2.25	--
503	1.3	4.45
504	2.1	1.62
505	2.0	3.49
506	2.9	1.11
507	1.5	1.52
508	<–2.25	--
509	1.7	2.00
510	1.8	1.62
523	2.4	1.47
554	2.5	1.19
564	<–2.25	--
565	1.5	1.68
566	2.2	1.24
567	1.8	1.86
568	3.1	1.32
569	3.0	1.23
571	<–2.25	3.56
572	3.1	1.42
574	1.9	1.68
575	3.5	1.15
586	2.5	1.19
629	0.4	4.10
630	–0.1	3.56
631	1.7	1.42
634	3.7	1.23
635	2.4	1.23
637	1.8	1.42
638	1.7	1.37
639	0.9	1.68
685	3.2	1.27
692	1.3	5.00
693	0.8	2.54
694	<–2.3	2.00
695	1.9	1.42
696	2.1	1.47
698	2.3	1.19
701	1.8	1.52
702	<–2.3	--
703	1.5	1.57
709	2.9	1.32
710	1.4	1.37
745	2.6	1.23
746	1.6	2.46
753	<–2.3	--
756	0.6	3.14
757	3.3	1.15
758	3.3	1.19
763	1.9	1.62
765	2.4	1.19
780	2.6	1.68
784	2.7	1.37
785	3.1	1.19
786	–1.6	2.33
789	1.8	1.52
790	2.9	1.19
794	2.6	1.15
797	<–2.3	1.19
799	2.7	1.23
800	1.7	3.72
803	2.9	1.52
806	3.2	1.27
810	<–2.25	--
811	1.4	2.46
813	2.8	1.15
817	2.7	1.23
820	0.9	1.86
821	2.8	1.23
822	2.0	1.42
832	2.00	1.27
846	–2.00	>4.00
848	–0.10	2.54
854	0.50	3.43
857	2.05	1.13
858	1.00	1.32
859	1.75	2.30
867	2.95	1.25
868	1.70	1.50
869	2.30	1.25
876	0.20	2.42
880	2.00	1.27
883	2.20	1.37
884	2.85	1.15
885	3.20	1.15
890	1.90	1.35
893	1.20	2.14
904	2.45	1.15
907	2.15	1.35
910	1.85	1.68
911	1.90	1.57
912	1.85	1.55
924	1.65	1.35
925	1.65	1.19
927	1.80	1.55
929	0.70	1.93
937	2.75	1.19
941	1.85	1.83
942	2.35	1.23
943	0.55	1.62
979	1.65	1.71
981	1.50	1.47
984	2.10	1.60
987	1.85	1.80
990	1.50	1.37
991	1.70	1.27
992	1.45	1.68
994	1.40	2.46
1029	1.85	1.35
1033	2.50	1.08
1040	1.85	1.47
1041	0.75	2.38
1042	1.35	1.97
1069	1.95	1.50
1071	1.95	1.21
1082	2.10	1.42
1084	2.50	1.15
1085	1.40	1.77
1099	2.15	1.55
1100	2.30	1.57
1109	1.85	1.37
1110	2.10	1.23
1112	2.10	1.25
1118	3.15	1.37
1119	2.55	1.35
1121	2.60	1.17
1122	2.00	1.25
1123	2.30	1.19
1124	2.75	1.25
1125	2.80	1.30
1126	2.65	1.19
1132	2.55	1.32
1133	2.20	1.32
1134	2.30	1.30
1136	2.55	1.25
1137	2.05	1.37
1142	2.65	1.55
1143	2.80	1.45
1144	1.70	1.80
1145	1.00	1.52
1146	2.80	1.27
1147	2.00	1.37
1151	1.55	1.35
1156	2.20	1.83
1157	2.65	1.15
1159	–0.15	1.93
1160	2.90	1.19
1167	3.00	1.27
1169	2.00	1.37
1171	2.55	1.40
1172	2.40	1.35
1188	0.15	2.77
1195	0.80	2.00
1221	3.25	1.15
1222	3.40	1.17
1223	3.25	1.21
1224	2.70	1.25
1225	3.30	1.21
1245	1.20	1.42
1246	–1.20	>2.38
1254	2.20	1.27
1262	2.00	1.37
1264	2.35	1.83
1284	3.35	1.19
1285	3.50	1.23
1286	3.30	1.65
1294	0.20	2.26
1340	1.70	1.35
1349	1.45	1.55
1350	3.40	1.19

TABLE C.—*Sediment data from core borings*

Station number	North latitude	West longitude	Water depth (ft)	Sediment thickness (ft)		Depth to bedrock (ft)	Elevation (ft above sea level)
				Lake deposit	Glacial till		
UM-1	41°33.7'	82°52.6'	21.0	24.5		45.5	523.1
UM-2	41°36.0'	82°55.4'	28.5	41.0		69.5	499.1
UM-3	41°37.2'	82°55.4'	29.5	38.0		67.5	501.1
UM-4	41°38.0'	82°51.8'	30.0	33.0		63.0	505.6
UM-5	41°39.0'	82°51.9'	31.5	34.5		66.0	502.6
UM-6	41°38.4'	82°50.6'	31.5	20.5		52.0	516.6
UM-7	41°38.8'	82°51.4'	33.5	86.0		119.5	449.1
UM-8	41°39.9'	82°50.6'	34.5	35.0		69.5	499.1
UM-9	41°39.5'	82°50.7'	35.0	59.0		94.0	474.6
UM-10	41°40.0'	82°49.6'	33.5	7.0		40.5	528.1
UM-11	41°39.4'	82°49.3'	12.0	8.0		20.0	548.6
UM-12	41°40.0'	82°48.8'	37.0	5.5		42.5	526.1
UM-13	41°40.9'	82°50.1'	35.0	47.5		82.5	486.1
UM-14	41°40.5'	82°49.4'	32.5	2.3		34.8	533.8
UM-15	41°40.2'	82°51.4'	34.0	71.0		105.0	463.6
UM-16	41°39.6'	82°51.6'	33.0	55.0		88.0	480.6
UM-17	41°39.9'	82°51.1'	36.0	63.0		99.0	469.6
UM-18	41°38.7'	82°52.4'	33.0	42.0		75.0	493.6
UM-19	41°39.9'	82°52.4'	33.0	53.0		86.0	482.6
UM-20	41°37.1'	82°49.5'	39.5	10.0		49.5	519.1
UM-21	41°35.9'	82°49.9'	28.0	10.0		38.0	530.6
UM-22	41°34.3'	82°51.6'	17.0	10.0		27.0	541.6
UM-23	41°38.8'	82°51.1'	32.7	94.3		127.0	441.6
UM-24	41°42.0'	82°49.5'	29.7	30.0		59.7	508.9
UM-25	41°42.1'	82°48.1'	27.0	7.0		34.0	534.6
UM-26	41°43.9'	82°48.9'	29.0	2.5		31.5	537.1
UM-27	41°42.8'	82°51.1'	15.0	1.0		16.0	552.6
UM-28	41°37.8'	82°51.4'	29.0	72.3		101.3	467.3
UM-29	41°36.6'	82°51.1'	28.0	27.1		55.1	513.5
UM-30	41°38.0'	82°48.9'	27.1	15.4		42.5	526.1
UM-31	41°39.4'	82°47.6'	28.0	5.4		33.4	535.2
UM-32	41°36.0'	82°47.6'	24.5	24.5		49.0	519.6
UM-33	41°38.7'	82°44.7'	35.0	44.0		79.0	489.6
UM-34	41°36.1'	82°44.8'	23.3	20.6		43.9	524.7
UM-35	41°35.1'	82°43.5'	24.4	11.0		35.4	533.2
UM-36	41°38.6'	82°41.8'	51.3	13.5		64.8	503.8
UM-37	41°40.4'	82°41.4'	33.0	50.3		83.3	485.3
UM-38	41°40.6'	82°44.3'	33.4	45.0		78.4	490.2
UM-39	41°36.6'	82°46.9'	25.5	6.8		32.3	536.3
UM-40	41°35.0'	82°47.3'	22.0	15.1		37.1	531.5
UM-41	41°33.9'	82°46.1'	22.8	37.6		60.4	508.2
UM-42	41°33.3'	82°43.9'	30.5	36.5		67.0	501.6
UM-43	41°34.3'	82°41.7'	32.7	29.0		61.7	506.9
UM-44	41°34.3'	82°43.7'	28.4	37.5		65.9	502.7
UM-45	41°35.0'	82°46.0'	21.0	27.9		48.9	519.7
UM-46	41°36.0'	82°45.9'	20.0	15.3		35.3	533.3
UM-47	41°34.3'	82°45.0'	25.9	28.0		53.9	514.7
UM-48	41°32.9'	82°42.0'	35.0	32.8		67.8	500.8
UM-49	41°35.1'	82°40.4'	32.0	1.5		33.5	535.1
UM-50	41°36.3'	82°39.2'	42.0	7.5		49.5	519.1
UM-51	41°37.7'	82°39.8'	32.7	9.1		41.8	526.8
UM-52	41°37.7'	82°41.6'	35.8	6.3		42.1	526.5
UM-53	41°37.8'	82°43.5'	35.5	36.0		71.5	497.1
UM-54	41°37.3'	82°45.4'	29.0	35.8		64.8	503.8
UM-55	41°38.4'	82°46.7'	29.0	34.5		63.5	505.1
UM-56	41°40.9'	82°52.4'	33.0	95.0		128.0	440.6
UM-57	41°41.3'	82°53.1'	32.5	44.8		77.3	491.3
UM-58	41°41.7'	82°52.7'	32.5	27.0		59.5	509.1
UM-59	41°42.2'	82°51.3'	32.9	34.2		67.1	501.5
UM-60	41°40.3'	82°50.7'	32.0	65.0		97.0	471.6
UM-61	41°40.8'	82°53.2'	32.0	41.7		73.7	494.9
UM-62	41°42.1'	82°52.1'	32.5	52.9		85.4	483.2

TABLE C.—*Sediment data from core borings*—Continued

Station number	North latitude	West longitude	Water depth (ft)	Sediment thickness (ft)		Depth to bedrock (ft)	Elevation (ft above sea level)
				Lake deposit	Glacial till		
UM-63	41°42.7'	82°46.6'	35.5		31.5	67.0	501.6
UM-64	41°41.9'	82°44.3'	36.3		37.7	74.0	494.6
UM-65	41°41.1'	82°42.5'	30.5		32.0	62.5	506.1
UM-66	41°39.5'	82°42.6'	35.0		48.7	83.7	484.9
UM-67	41°39.7'	82°45.2'	32.0		37.7	69.7	498.9
UM-68	41°33.3'	82°47.1'	16.9		20.5	37.4	531.2
UM-69	41°35.1'	82°48.8'	18.3		14.7	33.0	535.6
UM-70	41°36.0'	82°51.5'	25.5		52.2	77.7	490.9
UM-71	41°37.1'	82°51.9'	27.5		35.0	62.5	506.1
I-1	41°33.0'	82°43.1'	30.7	32.0	0.0	62.7	505.9
I-2	41°33.3'	82°42.9'	32.7	8.2	20.8	61.7	506.9
I-3	41°32.7'	82°43.1'	28.2	1.5	0.0	29.7	538.9
I-4	41°32.8'	82°43.1'	29.7	9.8	18.2	57.7	510.9
I-5	41°34.1'	82°43.2'	27.4	34.5	0.0	61.9	506.7
I-6	41°34.5'	82°42.8'	23.9	23.5	5.5	52.9	515.7
I-7	41°34.8'	82°41.9'	13.5	2.0+		15.5+	
I-8	41°34.3'	82°45.2'	22.6	30.5	0.0	53.1	515.5
I-9	41°33.3'	82°45.0'	25.2	21.5	0.0	46.7	521.9
I-10	41°35.7'	82°50.0'	25.9	4.0	11.0	40.9	527.7
I-11	41°36.1'	82°50.2'	26.0	0.0	at surface	26.0+	
I-12	41°36.8'	82°50.3'	31.0	24.5		55.5+	
I-13	41°37.2'	82°50.5'	32.5	8.0	10.0	50.5	518.1
I-14	41°37.2'	82°43.5'	29.3	16.0	at base	45.3+	
I-15	41°39.6'	82°47.2'	28.3	1.5	4.0	33.8	534.8
I-16	41°39.1'	82°46.3'	28.8	24.0	0.0	52.8	515.8
I-17	41°38.6'	82°45.3'	31.2	23.0	0.0	54.2	514.4
I-18	41°38.1'	82°44.4'	32.7	25.0	0.0	57.7	510.9
I-19	41°40.0'	82°49.8'	28.4	4.0	3.0	35.4	533.2
I-20	41°40.4'	82°50.1'	28.1	10.5	1.5	40.1	528.5
I-21	41°40.7'	82°50.5'	25.0	15.5	34.0+	74.5+	
I-22	41°38.4'	82°40.7'	49.5	3.0	4.0	56.5	512.1
I-23	41°38.9'	82°41.1'	41.4	1.7	3.3	46.4	522.2
I-24	41°40.5'	82°41.4'	32.4	0.0	at surface	32.4+	
I-25	41°39.9'	82°41.8'	21.9	12.0	1.0	34.9	533.7
I-26	41°33.1'	82°46.6'	15.8	28.5	0.0	44.3	524.3
I-27	41°33.5'	82°46.3'	18.2	32.0	0.0	50.2	518.4
I-28	41°34.0'	82°45.8'	21.8	32.5	1.0	55.3	513.3
I-29	41°34.8'	82°45.2'	21.3	12.0	6.0	39.3	529.3
I-30	41°35.6'	82°44.7'	19.3	5.0	3.0	27.3	541.3
I-31	41°35.5'	82°47.8'	17.8	2.5	5.0	25.3	543.3
I-32	41°35.0'	82°47.8'	20.8	9.5	7.0+	37.3+	
I-33	41°32.3'	82°42.2'	25.3	12.5	0.0	37.8	530.8
I-34	41°32.3'	82°41.4'	31.3	18.0	14.0	63.3	505.3
I-35	41°32.4'	82°40.4'	33.3	30.5	8.5	72.3	496.3
I-36	41°32.3'	82°39.4'	35.6	38.5	2.7	76.8	491.8
I-37	41°33.5'	82°39.5'	38.4	43.1	3.4	84.9	483.7
I-38	41°33.4'	82°40.6'	35.8	42.5	0.0	78.3	490.3
I-39	41°33.7'	82°41.8'	31.8	34.7	13.8+	80.3+	
I-40	41°34.7'	82°40.2'	35.8	4.5	9.0	49.3	519.3
I-41	41°33.8'	82°44.6'	25.8	35.0	4.0	64.8	503.8
I-42	41°34.4'	82°46.9'	21.3	7.0	9.5	37.8	530.8
I-43	41°32.8'	82°45.5'	15.3	1.0	3.0	19.3	549.3
I-44	41°31.0'	82°42.8'	11.6	36.0	2.0	49.6	519.0
I-45	41°30.2'	82°42.2'	8.6	35.0	0.0	43.6	525.0
I-46	41°29.8'	82°41.9'	8.6	50.5	0.0	59.1	509.5
I-47	41°41.1'	82°42.5'	29.2	2.0	20.5	51.7	516.9
I-48	41°41.4'	82°43.4'	34.0	31.0	0.0	65.0	503.6
I-49	41°41.6'	82°44.6'	34.6	30.5	8.0	73.1	495.5
I-50	41°41.9'	82°45.4'	35.8	6.5	7.0	49.3	519.3
I-51	41°41.2'	82°46.6'	23.8	38.5	0.0	62.3	506.3
I-52	41°39.3'	82°43.5'	33.6	17.5	13.0	64.1	504.5
I-53	41°39.0'	82°53.1'	27.1	5.0	14.5	46.6	522.0

TABLE C.—*Sediment data from core borings*—Continued

Station number	North latitude	West longitude	Water depth (ft)	Sediment thickness (ft)		Depth to bedrock (ft)	Elevation (ft above sea level)
				Lake deposit	Glacial till		
I-54	41°39.3'	82°54.3'	27.6	42.4	0.0	70.0	498.6
I-55	41°39.6'	82°55.5'	28.1	31.5	0.0	59.6	509.0
I-56	41°31.2'	82°55.2'	7.6	17.0	5.5	30.1	538.5
I-57	41°31.1'	82°55.7'	7.1	25.0	0.0	32.1	536.5
I-58	41°31.9'	82°56.1'	13.1	1.0	9.5	23.6	545.0
I-59	41°31.9'	82°55.1'	14.1	0.5	8.0+	22.6+	
I-60	41°31.9'	82°53.8'	14.6	16.0	6.0	36.6	532.0
I-61	41°34.6'	82°52.4'	20.1	15.0	0.0	35.1	533.5
I-62	41°34.6'	82°53.6'	21.1	3.5	9.5+	34.1+	
I-63	41°34.5'	82°54.8'	21.1	4.0	1.0	26.1	542.5
I-64	41°38.1'	82°51.3'	25.6	13.9	3.5	43.0	525.6
I-65	41°39.3'	82°52.4'	28.0	4.0	25.5	57.5	511.1
I-66	41°40.2'	82°52.5'	29.5	5.5	68.5	103.5	465.1
I-67	41°40.6'	82°50.8'	26.0	27.0	7.0+	60.0+	
I-68	41°40.3'	82°51.7'	31.0	3.0	11.0+	45.0+	
I-69	41°41.1'	82°51.6'	32.5	18.5	2.5+	53.5+	
I-70	41°41.9'	82°51.5'	31.0	13.0	30.0	74.0	494.6
I-71	41°44.6'	82°51.7'	30.0	17.0	2.5	49.5	519.1
I-72	41°43.7'	82°51.4'	30.0	16.0	6.5	52.5	516.1
I-74	41°37.9'	82°48.7'	24.5	4.0	4.0	32.5	536.1
I-75	41°37.1'	82°49.0'	61.5	11.0	0.0	72.5	496.1
I-76	41°42.2'	82°48.4'	30.5	20.0	0.0	50.5	518.1
I-77	41°37.0'	82°46.1'	25.5	13.0	28.0	66.5	502.1
I-78	41°37.9'	82°46.4'	26.5	16.0	18.5+	61.0+	
I-80	41°38.1'	82°50.8'	27.5	34.0	6.5	68.0	500.6
I-81	41°37.9'	82°50.5'	26.5	0.1	3.9	30.5	538.1
I-82	41°52.7'	82°56.2'	33.5	8.0	2.5	44.0	524.6
I-83	41°39.4'	82°56.4'	27.0	14.0	26.5+	67.5+	
I-84	41°39.8'	82°57.3'	25.5	12.0	6.0	43.5	525.1
I-85	41°40.0'	82°58.6'	9.0	0.0	0.0	9.0	559.6
I-86	41°41.1'	82°58.4'	29.2	9.4	6.0	44.6	524.0
I-87	41°46.0'	82°52.1'	32.5	9.5	5.0	47.0	521.6
I-91	41°45.1'	82°49.9'	22.5	0.0	0.0	22.5	546.1
I-93	41°42.6'	82°50.5'	9.5	0.0	0.0	9.5	559.1
I-98	41°39.6'	82°41.4'	2.0	0.0	0.0	2.0	566.6
I-99	41°36.7'	82°48.9'	10.0	0.0	0.0	10.0	558.6
I-100	41°37.9'	83°01.4'	8.0	0.0	0.0	8.0	560.6
I-101	41°38.3'	82°38.5'	11.0	0.0	0.0	11.0	557.6
I-105	41°36.7'	83°00.3'	11.5	8.0	3.0	22.5	546.1
I-218	41°37.9'	83°06.7'	12.0	0.0	at surface	12.0+	
I-219	41°38.9'	83°06.7'	17.5	2.5	15.0	35.0	533.6
I-220	41°45.0'	83°10.0'	26.0	7.0	5.0	38.0	530.6
P-4	41°33.0'	83°00.9'	8.5	0.5	26.0+	35.0+	
EH-8	41°32.6'	82°47.1'	2.4	23.1	at base	20.5+	
CP-1	41°26.0'	82°37.0'	8.1	37.4	2.5	48.0	520.6
CP-2	41°28.9'	82°40.6'	9.5	16.5	0.0	26.0	542.6
CP-3	41°29.0'	82°40.5'	3.0	15.5	0.0	18.5	550.1
CP-4	41°29.2'	82°40.3'	13.0	22.0	0.0	35.0	533.6
CP-5	41°26.1'	82°37.0'	10.5	37.5	at base	48.0+	
CP-6	41°25.4'	82°36.1'	7.0	43.5	0.5	51.0	517.6
CP-7	41°25.6'	82°36.0'	16.5	35.0	9.5	61.0	507.6
CP-8	41°25.2'	82°35.7'	5.0	20.0	18.5+	43.5+	
CP-9	41°25.4'	82°35.9'	7.5	7.5+		15.0+	
7301	41°29.85'	82°41.31'	19.5	14.5+		34.0+	
7302	41°29.97'	82°41.08'	20.5	17.0+		37.5+	
7303	41°30.08'	82°40.86'	19.1	37.0	0.0	56.1	512.5
7304	41°30.17'	82°40.66'	18.0	44.0	0.0	62.0	506.6
7305	41°30.02'	82°41.34'	15.5	35.0	0.0	50.5	518.1
7306	41°30.08'	82°41.17'	17.5	41.5	0.0	59.0	509.6
7307	41°30.23'	82°40.98'	16.5	38.0	0.0	54.5	514.1
7308	41°30.28'	82°40.76'	20.0	35.0	0.0	55.0	513.6
7309	41°30.49'	82°40.86'	22.5	32.5	0.0	55.0	513.6

TABLE C.—*Sediment data from core borings*—Continued

Station number	North latitude	West longitude	Water depth (ft)	Sediment thickness (ft)		Depth to bedrock (ft)	Elevation (ft above sea level)
				Lake deposit	Glacial till		
7310	41°30.36'	82°41.09'	19.0	25.0+		44.0+	
7311	41°30.21'	82°41.30'	15.0	40.5	0.0	55.5	513.1
7312	41°30.12'	82°41.47'	12.5	31.5	0.0	44.0	524.6
7313	41°30.68'	82°40.95'	23.5	30.5	0.0	54.0	514.6
7314	41°30.56'	82°41.19'	20.5	24.0	0.0	44.5	524.1
7315	41°30.38'	82°41.44'	17.5	20.0+		37.5+	
7316	41°30.32'	82°41.86'	13.5	33.0	0.0	46.5	522.1
7317	41°29.41'	82°42.37'	8.0	30.0+		38.0+	
7318	41°29.21'	82°43.02'	8.1	42.0	0.0	50.1	518.5
7319	41°28.79'	82°41.60'	6.5	35.0	0.0	41.5	527.1
7320	41°28.43'	82°41.20'	8.4	17.0	0.0	25.4	543.2
7321	41°29.92'	82°39.16'	28.9	43.0	0.0	71.9	496.7
7322	41°29.75'	82°37.54'	33.7	21.0	0.0	54.7	513.9
7323	41°30.77'	82°38.28'	33.7	50.0	0.0	83.7	484.9
R-748	41°28.2'	82°37.4'	29.1	21.5	0.0	50.6	518.0
R-1455	41°40.4'	82°50.5'	28.1	7.9	45.1	81.1	487.5
7120	41°31.5'	82°37.4'	41.3	42.5	0.0	83.8	484.8
7121	41°33.3'	82°37.4'	43.3	38.0	2.0	83.3	485.3
7122	41°35.0'	82°37.4'	41.8	33.5	3.5+	78.8+	
WR-1	41°44.2'	82°52.6'	31.2	19.1	7.1	57.4	511.2
WR-2	41°44.2'	82°57.1'	30.8	25.1	3.0	58.9	509.7
WR-3	41°44.2'	82°59.7'	29.4	30.3	2.8	62.5	506.1
WR-4	41°44.2'	83°01.9'	29.2	16.2	16.5	61.9	506.7
WR-5	41°44.2'	83°04.2'	27.8	19.4	1.8	49.0	519.6
WR-6	41°42.4'	82°59.7'	29.5	23.5	0.0	53.0	515.6
WR-7	41°42.4'	82°57.1'	30.0	20.5	6.7	57.2	511.4
WR-8	41°40.7'	82°53.1'	30.7	33.8	12.5	77.0	491.6
WR-9	41°40.6'	83°04.3'	25.2	4.5	10.6	40.3	528.3
WR-10	41°39.5'	82°59.2'	20.9	0.1	1.7	22.7	545.9
WR-11	41°37.2'	82°53.1'	25.1	30.0	10.5	65.6	503.0
WR-12	41°35.5'	82°53.2'	23.2	24.7	12.0+	59.9+	
WR-13	41°36.2'	82°58.8'	19.6	22.8	6.2	48.6	520.0
WR-14	41°32.8'	82°59.5'	12.0	3.2	12.6	27.8	540.8
WR-15	41°38.5'	82°50.5'	28.1	26.6	8.0	62.7	505.9
WR-16	41°45.0'	82°51.1'	31.9	5.3	14.0	51.2	517.4
WR-17	41°43.1'	83°06.6'	27.7	7.5	17.1	52.3	516.3
WR-18	41°32.2'	82°58.0'	9.5	0.1	10.8	20.4	548.2
WR-19	41°41.4'	83°06.6'	22.2	8.0	9.0	39.2	529.4
WR-20	41°45.0'	82°52.3'	32.0	5.2	12.0	49.2	519.4
WR-21	41°39.6'	83°06.6'	18.7	1.5	18.3	38.5	530.1
WR-22	41°37.9'	83°06.6'	10.2	0.2	14.3	24.7	543.9
WR-23	41°37.1'	83°06.6'	7.7	0.0	3.5	11.2	557.4
WR-24	41°32.8'	82°55.0'	16.4	0.3	15.2	31.9	536.7
WR-25	41°33.8'	82°55.0'	17.7	0.1	15.6	33.4	535.2
WR-26	41°35.5'	82°55.0'	22.5	4.5	26.2	53.2	515.4
WR-27	41°36.4'	82°55.0'	24.4	16.1	26.0+	66.5+	
WR-28	41°37.2'	82°55.0'	25.5	25.5	14.0+	65.0+	
WR-29	41°38.1'	82°55.0'	26.5	8.9	21.2	56.6	512.0
WR-30	41°38.8'	82°55.1'	28.2	9.3	30.1	67.6	501.0
WR-31	41°40.7'	82°55.0'	30.4	15.7	21.0	67.1	501.5
WR-32	41°41.6'	82°55.0'	30.5	15.6	25.7	71.8	496.8
WR-33	41°42.4'	82°55.0'	31.2	13.0	22.0	66.2	502.4
WR-34	41°43.3'	82°55.0'	31.6	14.5	20.0	66.1	502.5
WR-35	41°44.2'	82°55.0'	32.0	14.0	21.7	67.7	500.9
WR-36	41°45.0'	82°53.4'	32.0	13.8	27.2	73.0	495.6
WR-37	41°40.8'	83°00.4'	28.1	4.0	3.7	35.8	532.8
WR-38	41°41.3'	82°01.3'	28.2	8.5	5.0	41.7	526.9
WR-39	41°41.9'	83°02.2'	27.7	9.5	9.9	47.1	521.5
WR-40	41°42.4'	83°03.2'	27.9	8.1	7.0	43.0	525.6
WR-41	41°37.8'	83°04.1'	13.8	0.3	9.1	23.2	545.4
WR-42	41°37.0'	83°02.2'	15.4	3.0	16.0+	34.4+	
WR-43	41°35.4'	83°03.3'	2.6	19.9+		22.5+	

TABLE C.—*Sediment data from core borings*—Continued

Station number	North latitude	West longitude	Water depth (ft)	Sediment thickness (ft)		Depth to bedrock (ft)	Elevation (ft above sea level)
				Lake deposit	Glacial till		
WR-44	41°35.8'	83°02.2'	13.4	1.8	1.9	17.1	551.5
WR-45	41°36.2'	83°01.2'	14.8	0.8	4.7	20.3	548.3
WR-46	41°37.5'	82°58.2'	22.4	9.0	21.5	52.9	515.7
WR-47	41°37.9'	82°57.1'	25.4	6.0	14.0+	45.4+	
WR-48	41°42.9'	83°04.1'	28.2	12.1	3.3	43.6	525.0
WR-49	41°43.4'	83°05.1'	27.9	12.7	7.1	47.7	520.9
WR-50	41°38.9'	83°02.0'	20.0	0.1	8.0	28.1	540.5
WR-51	41°36.4'	82°57.1'	22.9	18.0	18.5	59.4	509.2
WR-52	41°36.4'	82°52.6'	25.0	15.8	16.1	56.9	511.7
WR-53	41°32.8'	82°52.6'	15.7	3.9	11.3	30.9	537.7
WR-54	41°32.8'	82°57.1'	14.3	0.1	11.9	26.3	542.3
WR-55	41°34.6'	82°56.0'	21.1	7.0	7.0+	35.1+	
WR-56	41°34.6'	82°57.1'	20.2	6.1	23.3+	49.6+	
WR-57	41°34.6'	82°58.3'	19.5	9.9	10.2	39.6	529.0
WR-58	41°34.6'	82°59.5'	17.9	12.7	6.5	37.1	531.5
WR-59	41°34.6'	83°00.7'	16.8	8.3	5.5	30.6	538.0
WR-60	41°34.6'	83°01.8'	14.4	6.2	4.4	25.0	543.6
WR-61	41°38.1'	82°52.6'	27.9	5.5	9.5	42.9	525.7
WR-62	41°42.5'	82°53.1'	31.5	8.6	21.6	61.7	506.9
WR-63	41°28.3'	82°39.2'	24.0	5.3	0.0	29.3	539.3
WR-64	41°28.3'	82°41.6'	24.3	25.6	14.8	64.7	503.9
WR-65	41°36.7'	82°41.9'	2.3	10.0	2.5	14.8	553.8
WR-66	41°33.9'	82°48.5'	6.0	4.0	2.3	12.3	556.3
WR-67	41°34.2'	82°48.8'	7.5	6.5	1.3	15.3	553.3
WR-68	41°34.0'	82°48.8'	5.3	4.0	1.0	10.3	558.3
WR-69	41°40.2'	82°39.7'	35.5	5.1	7.3	47.9	520.7
WR-70	41°40.2'	82°37.3'	36.8	24.0	31.4	92.2	476.4
WR-71	41°38.5'	82°37.2'	47.4	12.4	27.3	87.1	481.5
WR-72	41°36.7'	82°37.2'	42.8	8.5	14.7	66.0	502.6
WR-73	41°37.3'	82°47.2'	24.8	20.0	15.5+	60.3+	
WR-74	41°36.8'	82°41.7'	16.4	0.3	8.4	25.1	543.5
WR-75	41°31.3'	82°39.4'	31.3	18.1	10.4	59.8	508.8

TABLE D.—*Descriptive logs of core borings*

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-1	1	0.0-1.1	30.7	537.9	Mud, dark-gray; sand, fine-grained, soft
30.7 ft	2	1.1-3.0	31.8	536.8	Clay, gray-brown; laminated with silt
5/16/60	3	3.0-3.6	33.7	534.9	Peat, dark-brown
		4.0-8.0	34.7	533.9	Sand
	4	10.0	40.7	527.9	Plant detritus with slight clay content
		32.0	62.7	505.9	Bedrock, questionable contact
I-2	1	0.0-3.0	32.7	535.9	Mud, gray and brown
32.7 ft	2	8.0-8.2	40.7	527.9	Sand, gray, fine-grained, silty; gravel
5/16/60	3	8.2-8.5	40.9	527.7	Till, gray
		29.0	61.7	506.9	Bedrock, questionable contact
I-3	1	0.0-1.1	28.2	540.4	Clay, stiff; overlain by veneer of coarse gravel
28.2 ft		1.5	29.7	538.9	Bedrock, questionable contact
5/18/60					
I-4	1	0.0	29.7	538.9	Mud, dark-gray and brown
29.7 ft	2	6.0	35.7	532.9	Clay, gray-brown, soft, silty; shells
5/18/60		9.8	39.5	529.1	Top of till
		28.0	57.7	510.9	Bedrock, questionable contact
I-5	1	0.0	27.4	541.2	Sand, fine-grained; mud, gray
27.4 ft	2	8.0-11.0	35.4	533.2	Clay, gray, soft, silty; sand layers; shells
5/19/60	3	13.0-14.0	40.4	528.2	Sand, brown and gray, very fine-grained, silty; some plant detritus
	4	18.0-18.5	45.4	523.2	Sand, dark-brown, fine-grained, silty; shells; much plant detritus; overlies gray clay
	5	20.0	47.4	521.2	Clay, brown, mottled, stiff; plant detritus
		34.5	61.9	506.7	Bedrock, questionable contact
I-6	1	0.0	23.9	544.7	Sand, brown, fine-grained, silty
23.9 ft	2	6.5	30.4	538.2	Sand, gray-brown, fine-grained, silty
5/19/60	3	11.5-12.8	35.4	533.2	Clay, gray, soft, silty
	4	16.5	40.4	528.2	Clay, brown, very stiff, mottled, lacustrine
		23.5	47.4	521.2	Top of till
		29.0	52.9	515.7	Bedrock, questionable contact
I-7	1	0.0	13.5	555.1	Sand and gravel, coarse, clean
13.5 ft		2.0	15.5	553.1	Refusal in coarse gravel
5/23/60					
I-8	1	0.0	22.6	546.0	Silt, gray and brown, clayey
22.6 ft	2	3.0-5.0	25.6	543.0	Sand and gravel
5/23/60	3	8.0-9.0	30.6	538.0	Clay, gray, soft, silty, sticky
	4	13.0	35.6	533.0	Clay, gray, stiff; shells
	5	16.5	39.1	529.5	Clay, gray-brown, stiff
		30.5	53.1	515.5	Bedrock, questionable contact
I-9	1	0.0	25.2	534.4	Sand, brown-gray, silty; gravel
25.2 ft	2	5.5	30.7	537.9	Sand
5/23/60	3	10.5	35.7	532.9	Sand
	4	20.5	45.7	522.9	Sand
		21.5	46.7	521.9	Refusal in gravel
I-10	1	0.0	25.9	542.7	Mud, gray and brown
25.9 ft	2	4.0	29.9	538.7	Till, red-brown, very hard
5/25/60		15.0	40.9	527.7	Bedrock, questionable contact
I-11		0.0	26.0	542.6	Till at surface
26.0 ft					
5/25/60					
I-12	1	0.0	31.0	537.6	Mud, gray-brown
31.0 ft	2	9.5	40.5	528.1	Silt, brown; shells; plant detritus
5/25/60	3	14.5	45.5	523.1	Silt, brown; plant detritus
	4	19.5	50.5	518.1	Silt, brown; plant detritus; strong H_2S
		24.5	55.5	513.1	Refusal in sand and gravel

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-13	1	0.0	32.5	536.1	Sand and gravel, mixed with mud
32.5 ft	2	8.0	40.5	528.1	Clay, gray, stiff
5/25/60		18.0	50.5	518.1	Bedrock, questionable contact
I-14	1	0.0	29.3	539.3	Mud, gray; some gravel
29.3 ft	2	6.0	35.3	533.3	Clay, gray, soft, sticky
5/26/60	3	11.0	40.3	528.3	Clay, gray, soft; shells; plant detritus
	4	16.0	45.3	523.3	Till, red, very hard
I-15	1	0.0	28.3	540.3	Mud, gray and brown
28.3 ft	2	1.5	29.8	538.8	Till, red
5/26/60		5.5	33.8	534.8	Bedrock, questionable contact
I-16	1	0.0	28.8	539.8	Mud, gray and brown
28.8 ft	2	6.5-7.5	35.3	533.3	Clay, gray, soft, tenacious
5/26/60	3	7.5-7.7	36.3	532.3	Plant detritus
	4	7.7-8.0	36.5	532.1	Clay, gray, stiff; plant detritus
	5	11.5-11.8	40.3	528.3	Clay, gray, stiff; plant detritus
		24.0	52.8	515.8	Bedrock, questionable contact
I-17	1	0.0	31.2	537.4	Mud, gray-brown
31.2 ft	2	9.0	40.2	528.4	Clay, gray, stiff, sticky; plant detritus
5/26/60		23.0	54.2	514.4	Bedrock, questionable contact
I-18	1	0.0	32.7	535.9	Mud, gray-brown
32.7 ft	2	7.5-8.5	40.2	528.4	Clay, gray, soft; overlies 0.5 ft clayey plant detritus
5/26/60	3	12.5	45.2	523.4	Clay, gray, stiff; some plant detritus
		25.0	57.7	510.9	Bedrock, questionable contact
I-19	1	0.0	28.4	540.2	Sand and gravel, silty
28.4 ft	2	3.0	31.4	537.2	Clay, very hard
6/1/60	3	4.0	32.4	536.2	Till, brown, hard
		7.0	35.4	533.2	Bedrock, questionable contact
I-20	1	0.0	28.1	540.5	Mud, gray, silty; some fine-grained sand
28.1 ft	2	6.0	34.1	534.5	Clay, hard
6/1/60	3	7.5	35.6	533.0	Clay, gray-brown, stiff; plant detritus
	4	10.5	38.6	530.0	Till, red; overlain by stiff gray clay with plant detritus
		12.0	40.1	528.5	Bedrock, questionable contact
I-21	1	0.0	25.0	543.6	Mud, dark-gray
25.0 ft	2	10.5-11.0	35.5	533.1	Silt, brown; grades down to 100 percent plant detritus at base
6/1/60	3	15.5	40.5	528.1	Clay, light-gray, moderately stiff; pebbles
		49.5	74.5	494.1	Stopped in clay, no refusal
I-22	1	0.0	49.5	519.1	Mud, gray
49.5 ft	2	3.0	52.5	516.1	Till clay, hard
6/10/60		7.0	56.5	512.1	Bedrock, questionable contact
I-23	1	0.0	41.4	527.2	Sand, dark, coarse-grained; mud; methane odor
41.4 ft	2	1.7	43.1	525.5	Till, brown
6/10/60		5.0	46.4	522.2	Bedrock, questionable contact
I-24	1	0.0	32.4	536.2	Till at surface
32.4 ft					
6/10/60					
I-25	1	0.0	21.9	546.7	Sand and gravel, shells
21.9 ft	2	8.5	30.4	538.2	Sand, fine-grained, dirty; shell fragments
6/10/60	3	10.5	32.4	536.2	Gravel
		12.0	33.9	534.7	Top of till
		13.0	34.9	533.7	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-26	1	0.0	15.8	552.8	Mud, dark-gray
15.8 ft	2	9.5-10.1	25.3	543.3	Peat, dark-brown; broadleaf grass fragments
7/5/60	3	10.1-10.3	25.9	542.7	Clay, gray, soft; plant detritus
	4	12.5-12.8	28.3	540.3	Clay, gray-brown, stiff, laminated
		23.0-27.0	38.8	529.8	Soft layer, easy jetting
		28.5	44.3	524.3	Bedrock, questionable contact
I-27	1	0.0	18.2	550.4	Mud, gray; sand, fine-grained
18.2 ft	2	7.0-8.0	25.2	543.4	Sand, gray, fine-grained, silty; plant detritus
7/5/60	3	12.0-12.3	30.2	538.4	Clay, dark-gray-brown, stiff; plant detritus
	4	17.0-17.3	35.2	533.4	Clay, gray-brown, stiff, tenacious; mottled with red and blue
		32.0	50.2	518.4	Bedrock, questionable contact
I-28	1	0.0	21.8	546.8	Sand, gray-brown, fine-grained, muddy; some gravel
21.8 ft	2	3.5	25.3	543.3	Sand, gray, fine-grained, silty; plant detritus
7/7/60	3	8.5-9.5	30.3	538.3	Clay, gray, soft, silty; layers of shells
	4	13.5-14.5	35.3	533.3	Clay, gray, soft, silty
	5	18.5-19.5	40.3	528.3	Clay, gray-brown, moderately stiff, brittle
		26.0-28.0	47.8	520.8	Hard layer
		28.0-32.5	49.8	518.8	Soft layer
		32.5-33.5	54.3	514.3	Hard layer
		33.5	55.3	513.3	Bedrock, questionable contact
I-29	1	0.0	21.3	547.3	Sand, gray and brown, fine-grained, silty; clam shells
21.3 ft	2	4.0	25.3	543.3	Sand, gray, fine-grained, silty; shells; plant detritus
7/7/60	3	9.0	30.3	538.3	Clay, gray, sandy; many small shells
	4	12.0	33.3	535.3	Till, brown, hard, pebbly
		18.0	39.3	529.3	Bedrock, questionable contact
I-30	1	0.0	19.3	549.3	Silt, gravel and shell fragments
19.3 ft	2	5.0	24.3	544.3	Till, gray, hard, pebbly
7/7/60		8.0	27.3	541.3	Bedrock, questionable contact
I-31	1	0.0	17.8	550.8	Sand, medium-grained, clean, well-sorted
17.8 ft	2	2.5	20.3	548.3	Till, gray-brown, stiff; mottled with red; black shale fragments
7/7/60		7.5	25.3	543.3	Bedrock, questionable contact
I-32	1	0.0	20.8	547.8	Mud, gray-brown
20.8 ft	2	4.5	25.3	543.3	Clay, gray and brown, stiff; laminated with silt
7/7/60		7.5-9.5	28.3	540.3	Soft layer
		9.5-11.5	30.3	538.3	Top of till
		16.5	37.3	531.3	Refusal in till clay
I-33	1	0.0	25.3	543.3	Mud, gray; some very fine-grained sand
25.3 ft	2	5.0	30.3	538.3	Sand, gray, very fine-grained, silty
7/8/60	3	10.0	35.3	533.3	Sand, gray, very fine-grained, silty
	4	10.5-12.5	35.8	532.8	Gravel
		12.5	37.8	530.8	Bedrock, questionable contact
I-34	1	0.0	31.3	537.3	Mud, gray
31.3 ft	2	9.0-10.0	40.3	528.3	Clay, gray; laminated with black bands
7/8/60	3	14.0-14.5	45.3	523.3	Clay, gray-brown, stiff, silty; mottled with red
		18.0	49.3	519.3	Top of till
		32.0	63.3	505.3	Bedrock, questionable contact
I-35	1	0.0	33.3	535.3	Mud, gray; sand, fine-grained
33.3 ft	2	7.0-9.0	40.3	528.3	Clay, gray, very soft; with black bands
7/8/60	3	12.0-13.0	45.3	523.3	Clay, gray, very soft; with black bands
	4	13.0-13.5	46.3	522.3	Clay, gray-brown, stiff; plant detritus
	5	17.0-17.5	50.3	518.3	Clay, brown, stiff, laminated; plant detritus
		30.5	63.8	504.8	Top of till
		39.0	72.3	469.3	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-36	1	0.0	35.6	533.0	Mud, dark-gray
35.6 ft	2	9.7-11.0	45.3	523.3	Clay, gray, soft; black streaks
7/18/60	3	14.7-15.0	50.3	518.3	Clay, gray-brown, laminated; some plant detritus
	4	19.5-19.8	55.1	513.5	Clay, dark-brown and gray, stiff, silty, lacustrine
		38.5	74.1	494.5	Top of till
		41.2	76.8	491.8	Bedrock, questionable contact
I-37	1	0.0	38.4	530.2	Mud, dark-gray
38.4 ft	2	7.0-7.5	45.4	523.2	Clay, gray, very soft, tenacious; black streaks
7/18/60	3	8.0-12.0	50.4	518.2	Clay, dark-gray, very soft, silty
	4	13.0-13.4	55.4	513.2	Clay, gray-brown, tenacious, lacustrine
		43.1	81.5	487.1	Top of till
		46.5	84.9	483.7	Bedrock, questionable contact
I-38	1	0.0	35.8	532.8	Mud, gray
35.8 ft	2	9.5-10.5	45.3	523.3	Clay, gray, very soft
7/18/60	3	14.5-15.0	50.3	518.3	Sand, gray, fine-grained; wood; plant detritus
	4	19.5-20.0	55.3	513.3	Clay, gray, moderately stiff
		42.5	78.3	490.3	Bedrock, questionable contact
I-39	1	0.0	31.8	536.8	Mud, gray; sand, fine-grained
31.8 ft	2	3.5-4.0	35.3	533.3	Sand, gray, very fine-grained, silty; shells
7/19/60	3	8.5-9.0	40.3	528.3	Clay, gray, very soft, very silty
	4	13.5-14.5	45.3	523.3	Clay, gray, very soft; black streaks
	5	18.5-18.8	50.3	518.3	Clay, gray and brown, moderately stiff, lacustrine
	6	23.0- 23.3	54.8	513.8	Clay, brown, stiff, laminated
		34.7	66.5	502.1	Top of till
		48.5	80.3	488.3	Refusal in till
I-40	1	0.0	35.8	532.8	Mud, dark-gray
35.8 ft	2	2.5-4.5	38.3	530.3	Sand and gravel, shells
7/19/60	3	4.5	40.3	528.3	Till, dark-brown
		13.5	49.3	519.3	Bedrock, questionable contact
I-41	1	0.0	25.8	542.8	Mud, dark-gray-brown, silty
25.8 ft	2	4.5-6.0	30.3	538.3	Sand, gray, fine-grained, silty; shells
7/21/60	3	9.5-10.0	35.3	533.3	Sand, gray, very fine-grained, silty; wood fragments
	4	14.5-15.2	40.3	528.3	Silt, dark-brown; much plant detritus
	5	19.5-20.3	45.3	523.3	Clay, dark-gray-brown, moderately stiff
		31.0-36.0	56.8	512.8	Soft layer
		35.0	60.8	507.8	Top of till
		39.0	64.8	503.8	Bedrock, questionable contact
I-42	1	0.0-2.5	21.3	547.3	Mud, gray-brown
21.3 ft	2	2.5-7.0	23.8	544.8	Sand
7/21/60		7.0	28.3	540.3	Top of till
		16.5	37.8	530.8	Bedrock, questionable contact
I-43	1	0.0	15.3	553.3	Sand, fine-grained; gravel; clay
15.3 ft	2	1.0-4.0	16.3	552.3	Till, hard
7/21/60		4.0	19.3	549.3	Bedrock, questionable contact
I-44	1	0.0	11.6	557.0	Mud, dark-gray-brown
11.6 ft	2	3.0-4.0	14.6	554.0	Sand, gray, fine-grained, clean
7/22/60	3	8.0-9.0	19.6	549.0	Sand, gray, fine-grained, clean
	4	13.0-13.5	24.6	544.0	Sand, gray, fine-grained, clean
	5	18.0-18.5	29.6	539.0	Silt, gray-brown, clayey; plant detritus
		18.5-27.0	30.1	538.5	Hard layer
		27.0-36.0	38.6	530.0	Soft layer
		36.0	47.6	521.0	Top of till
		38.0	49.6	519.0	Bedrock, questionable contact
I-45	1	0.0	8.6	560.0	Sand, brown, fine-grained, clean
8.6 ft	2	6.0-6.5	14.6	554.0	Sand, gray, fine-grained, silty
7/22/60	3	11.0-11.5	19.6	549.0	Sand, gray, fine-grained, silty
	4	16.0-16.5	24.6	544.0	Sand, gray, fine-grained, silty; some gravel
	5	16.5-17.0	25.1	543.5	Clay, dark-brown, silty; much plant detritus
	6	21.0-21.5	29.6	539.0	Clay, gray and brown, mottled, silty, stiff, laminated
		35.0	43.6	525.0	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-46	1	0.0	8.6	560.0	Sand, brown, fine-grained
8.6 ft	2	6.0	14.6	554.0	Sand, gray, fine-grained; some silt
7/22/60	3	11.0	19.6	549.0	Sand, gray, fine-grained; some silt
	4	16.0	24.6	544.0	Sand, gray, fine-grained; some silt
	5	31.0-39.0	39.6	529.0	Clay, soft; a few hard layers
	6	39.0-40.0	47.6	521.0	Gravel
	7	40.0-50.5	48.6	520.0	Clay, soft; a few hard layers
		50.5	59.1	509.5	Bedrock, questionable contact
I-47	1	0.0	29.2	539.4	Sand, brown, fine-grained, muddy
29.2 ft		2.0	31.2	537.4	Top of till
7/28/60		22.5	51.7	516.9	Bedrock, questionable contact
I-48	1	0.0	34.0	534.6	Mud, gray-brown, sandy
34.0 ft	2	11.0-11.5	45.0	523.6	Peat, brown; small snail shells
7/28/60	3	16.0-16.5	50.0	518.6	Clay, gray-brown, silty, moderately stiff
		16.5-18.1	50.5	518.1	Hard layer
		18.5-31.0	52.5	516.1	Soft zone
		31.0	65.0	503.6	Bedrock, questionable contact
I-49	1	0.0	34.6	534.0	Mud, gray; some sand
34.6 ft	2	10.5-11.0	45.1	523.5	Silt, brown, peaty
7/28/60	3	15.5-16.0	50.1	518.5	Peat, brown, silty
	4	20.5-21.5	55.1	513.5	Clay, light-gray, soft, sticky, laminated
	5	25.5-26.0	60.1	508.5	Clay, light-gray, soft, sticky; gravel
	6	30.5	65.1	503.5	Till, gray
		38.5	73.1	495.5	Bedrock, questionable contact
I-50	1	0.0	35.8	532.8	Mud, gray-brown
35.8 ft	2	6.5	42.3	526.3	Till, brown, pebbly
7/29/60		13.5	49.3	519.3	Bedrock, questionable contact
I-51	1	0.0	23.8	544.8	Mud, dark-gray; some sand
23.8 ft	2	11.5-12.0	35.3	533.3	Peat, dark-brown; silty in upper half
7/29/60	3	16.5-17.0	40.3	528.3	Clay, gray, stiff; some plant detritus
	4	21.5-22.0	45.3	523.3	Clay, gray, stiff, sticky, laminated
	5	26.5-27.2	50.3	518.3	Clay, gray, stiff, sticky; indistinct laminae
	6	31.5-32.2	55.3	513.3	Clay, gray, stiff, sticky; indistinct red laminae
	7	36.5-37.5	60.3	508.3	Clay, red, brown, and gray, soft, sandy
		38.5	62.3	506.3	Bedrock, questionable contact
I-52	1	0.0	33.6	535.0	Mud, gray-brown, sandy
33.6 ft	2	11.5-12.7	45.1	523.5	Clay, gray, soft, sandy
7/29/60	3	16.5-17.5	50.1	518.5	Clay, gray, brown, blue, red, laminated
		17.5	51.1	517.5	Top of till
		30.5	64.1	504.5	Bedrock, questionable contact
I-53	1	0.0	27.1	541.5	Mud, gray-brown
27.1 ft		5.0	32.1	536.5	Top of till
8/1/60		19.5	46.6	522.0	Bedrock, questionable contact
I-54	1	0.0	27.6	541.0	Mud, gray-brown
27.6 ft	2	7.5-8.0	35.1	533.5	Clay, gray-brown, mottled, stiff, lacustrine
8/1/60		42.4	70.0	498.6	Bedrock, questionable contact
I-55	1	0.0	28.1	540.5	Mud, gray-brown
28.1 ft	2	7.0-7.5	35.1	533.5	Clay, gray; sand, fine- to coarse-grained
8/1/60	3	12.0-12.2	40.1	528.5	Clay, gray and brown, mottled, stiff; distorted laminae
		31.5	59.6	509.0	Bedrock, questionable contact
I-56	1	0.0	7.6	561.0	Sand, brown, fine-grained, silty; some gravel
7.6 ft	2	4.5	12.1	556.5	Clay, blue and brown, mottled, stiff, lacustrine; contorted laminae
8/2/60	3	9.5-10.0	17.1	551.5	Clay, brown, stiff, laminated
		17.0	24.6	544.0	Top of till
		22.5	30.1	538.5	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-57 7.1 ft 8/2/60	1	0.0	7.1	561.5	Sand, fine-grained, silty; gravel
	2	3.0-4.0	10.1	558.5	Sand, dark-brown, fine-grained, silty, very soft; plant detritus
	3	8.0-8.5	15.1	553.5	Peat, brown, silty; clam and snail shells
	4	23.0-23.5	30.1	538.5	Peat, same as sample no. 3; wood
		25.0	32.1	536.5	Bedrock, questionable contact
I-58 13.1 ft 8/2/60	1	0.0	13.1	555.5	Sand, brown, fine-grained, silty; gravel
	2	1.0	14.1	554.5	Till, brown, hard, pebbly
		10.5	23.6	545.0	Bedrock, questionable contact
I-59 14.1 ft 8/2/60	1	0.0	14.1	554.5	Sand, fine-grained, silty; gravel
	2	0.5	14.6	554.0	Till, hard
		8.5	22.6	546.0	Refusal in till
I-60 14.6 ft 8/2/60	1	0.0	14.6	554.0	Mud, gray-brown, sandy
	2	6.0-6.5	20.6	548.0	Clay, gray-brown, stiff, tenacious
	3	11.0-11.5	25.6	543.0	Clay, brown, soft
	4	16.0	30.6	534.0	Till, gray-brown, stiff, pebbly
		22.0	36.6	532.0	Bedrock, questionable contact
I-61 20.1 ft 8/4/60	1	0.0	20.1	548.5	Mud, gray-brown
	2	5.0-6.0	25.1	543.5	Clay, gray, red-brown, mottled, stiff
		10.0	30.1	538.5	Sand and gravel
		15.0	35.1	533.5	Bedrock, questionable contact
I-62 21.1 ft 8/4/60	1	0.0	21.1	547.5	Mud, gray-brown
		3.5	24.6	544.0	Top of till
		13.0	34.1	534.5	Refusal in till
I-63 21.1 ft 8/4/60	1	0.0	21.1	547.5	Mud, gray-brown
	2	4.0	25.1	543.5	Till, dark-brown, very pebbly
		5.0	26.1	542.5	Bedrock, questionable contact
I-64 25.6 ft 8/9/60	1	0.0	25.6	543.0	Mud, gray-brown, sandy
	2	9.4-9.9	35.0	533.6	Clay, gray-brown, soft, silty; plant detritus
	3	13.9-14.2	39.5	529.1	Till, gray, stiff, pebbly
		17.4	43.0	525.6	Bedrock, questionable contact
I-65 28.0 ft 8/9/60	1	0.0	28.0	540.6	Mud, gray-brown
	2	4.0	32.0	536.6	Till, gray, hard
		29.5	57.5	511.1	Bedrock, questionable contact
I-66 29.5 ft 8/9/60	1	0.0	29.5	539.1	Mud, gray-brown
	2	5.5	35.0	533.6	Till, red-brown, stiff, pebbly
		74.0	103.5	465.1	Bedrock, questionable contact
I-67 26.0 ft 8/10/60	1	0.0	26.0	542.6	Mud, gray
	2	9.0-9.5	35.0	533.6	Silt, brown, very soft, very peaty; shells
	3	14.0-14.5	40.0	528.6	Silt, light-gray, sandy; plant detritus
	4	19.0-20.0	45.0	523.6	Clay, red and brown, mottled, soft, laminated
	5	24.0-25.0	50.0	518.6	Clay, gray-brown, soft; layered sand and gravel
	6	27.0-27.5	53.0	515.6	Till, gray, stiff, pebbly
		34.0	60.0	508.6	Refusal in gravel zone in till
I-68 31.0 ft 8/10/60	1	0.0-3.0	31.0	537.6	Mud, gray-brown
		3.0	34.0	534.6	Top of till
		14.0	45.0	523.6	Refusal in till
I-69 32.5 ft 8/18/60	1	0.0	32.5	536.1	Mud, gray
	2	7.5-8.0	40.0	528.6	Clay, gray, soft; large clam shells
	3	12.5-13.0	45.0	523.6	Clay, gray, stiff, silty; small snail shells
		18.5	51.0	517.6	Top of till
		21.0	53.5	515.1	Refusal in till
I-70 31.0 ft 8/18/60	1	0.0	31.0	537.6	Mud, gray
	2	9.0-9.5	40.0	528.6	Clay, gray, stiff, pebbly
	3	13.0	44.0	524.6	Till, brown, hard, pebbly
		43.0	74.0	494.6	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-71	1	0.0	30.0	538.6	Mud, dark-gray
30.0 ft	2	10.0-10.5	40.0	528.6	Clay, brown and red, mottled, moderately stiff
8/19/60	3	15.0-15.5	45.0	523.6	Sand, coarse-grained, silty; some stiff clay
		17.0	47.0	521.6	Top of till
		19.5	49.5	519.1	Bedrock, questionable contact
I-72	1	0.0	30.0	538.6	Mud, gray-brown
30.0 ft	2	5.0-6.5	35.0	533.6	Clay, gray, very soft
8/19/60	3	6.5-7.0	36.5	532.1	Clay, gray, soft; overlain by 0.2 ft peat
	4	10.0	40.0	528.6	Clay, dark-brown, stiff, laminated
		16.0	46.0	522.6	Top of till
		22.5	52.5	516.1	Bedrock, questionable contact
I-74	1	0.0	24.5	544.1	Mud, dark-gray-brown
24.5 ft	2	4.0	28.5	540.1	Till, gray, hard, pebbly
6/3/63		8.0	32.5	536.1	Bedrock, questionable contact
I-75	1	0.0	61.5	507.1	Mud, dark-gray-brown and black
61.5 ft	2	5.0	66.5	502.1	Sand, gray, fine- to very fine-grained
6/3/63		11.0	72.5	496.1	Bedrock, questionable contact
I-76	1	0.0	30.5	538.1	Mud, gray-brown, silty
30.5 ft	2	11.0-12.0	41.5	527.1	Clay, gray-brown, very soft
6/4/63	3	16.0-17.0	46.5	522.1	Clay, gray-brown, very soft, silty, laminated
		20.0	50.5	518.1	Bedrock, questionable contact
I-77	1	0.0	25.5	543.1	Mud, gray-brown, silty
25.5 ft	2	6.0-7.0	31.5	537.1	Clay, gray-brown, very soft, silty, laminated
6/6/63	3	11.0-12.0	36.5	532.1	Clay, brown, soft, silty; some shells; 0.1 ft dark-brown peat at base
	4	13.0-13.7	38.5	530.1	Till, red and brown, mottled, stiff, pebbly
		41.0	66.5	502.1	Bedrock, questionable contact
I-78	1	0.0	26.5	542.1	Mud, gray-brown, silty, gritty
26.5 ft	2	10.0	36.5	532.1	Silt, brown, soft, laminated; shell fragments
6/7/63	3	15.0	41.5	527.1	Clay, gray, soft, sticky
	4	16.0	42.5	526.1	Till, reddish-gray, hard
		34.5	61.0	507.6	Refusal in till
I-80	1	0.0	27.5	541.1	Mud, gray, silty; cinders
27.5 ft	2	9.0-10.0	36.5	532.1	Silt, gray-brown, silty; plant detritus; shells
6/14/63	3	14.0-15.0	41.5	527.1	Silt, light-gray-brown; snail shells, plant detritus; overlies 0.5 ft sand and brown peaty clay
	4	19.0-20.0	46.5	522.1	Clay, gray and black, mottled, soft; some plant detritus
	5	24.0-25.0	51.5	517.1	Clay, light-gray-brown, soft, smooth
	6	29.0-30.0	56.5	512.1	Clay, light-gray-brown, soft, smooth; few red laminae
	7	34.0-35.0	61.5	507.1	Till, reddish-gray, pebbly
		40.5	68.0	500.6	Bedrock, questionable contact
I-81	1	0.0-0.1	26.5	542.1	Gravel, ¼- to ¾-inch
26.5 ft		0.1	26.6	542.0	Top of till
6/14/63		4.0	30.5	538.1	Bedrock, questionable contact
I-82	1	0.0	33.5	535.1	Silt
33.5 ft	2	5.0	38.5	530.1	Clay, red, soft; few pebbles; silt layers
6/11/62	3	8.0	41.5	527.1	Till, brown, stiff, pebbly
		10.5	44.0	524.6	Bedrock, questionable contact
I-83	1	0.0	27.0	541.6	Mud, dark-gray
27.0 ft	2	3.0	30.0	538.6	Sand
6/17/64	3	4.5	31.5	537.1	Sand, fine-grained; underlain by hard brown clay
		14.0	41.0	527.6	Top of till
		40.5	67.5	501.1	Refusal in till
I-84	1	0.0	25.5	543.1	Mud, brown; mixed with medium- to coarse-grained sand and gravel
25.5 ft					
6/17/64	2	7.0	32.5	536.1	Clay, light-brown, tenacious, sandy
	3	12.0-12.5	37.5	531.1	Till, light-gray-brown; rounded gravel
		18.0	43.5	525.1	Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
I-85 9.0 ft 6/17/64		0.0	9.0	559.6	Bedrock; thin veneer of cobbles and gravel
I-86 29.2 ft 6/18/64, 8/5/68	1 2 3	0.0-0.5 5.9-6.9 9.4-9.5 15.4	29.2 35.1 38.6 44.6	539.4 533.5 530.0 524.0	Mud, light- to medium-gray, smooth; shells Till, laminated, disturbed; gravel Till, medium-gray, sandy, very hard; gravel Bedrock
I-87 32.5 ft 6/30/64	1 2	0.0 9.5-10.0 14.5	32.5 42.0 47.0	536.1 526.1 521.6	Mud, dark-gray Till, reddish-brown, hard; blue-gray streaks; gravel Bedrock, questionable contact
I-91 22.5 ft 7/3/64		0.0	22.5	546.1	Bedrock; thin veneer of cobbles and gravel
I-93 9.5 ft 7/7/64		0.0	9.5	559.1	Bedrock, overlain by gravel and boulders
I-98 2.0 ft 7/30/69	1	0.0	2.0	566.6	Sand, coarse-grained; cobbles
I-99 10.0 ft 7/30/69	1	0.0	10.0	558.6	Sand, coarse-grained; cobbles
I-100 8.0 ft 7/30/69	1	0.0	8.0	560.6	Bedrock; thin veneer of cobbles and gravel
I-101 11.0 ft 7/30/64	1	0.0	11.0	557.6	Bedrock; thin veneer of cobbles and gravel
I-105 11.5 ft 9/13/64	1 2	0.0 5.5-6.0 8.0 11.0	11.5 17.0 19.5 22.5	557.1 551.6 549.1 546.1	Sand, medium- to fine-grained Sand, coarse-grained; overlies hard chocolate-brown clay with red concretionary masses Top of till Bedrock, questionable contact
I-218 12.0 ft 8/19/65	1	0.0	12.0	556.6	Till, 1-inch and smaller gravel on bottom surface
I-219 17.5 ft 8/19/65	1	0.0 2.5 17.5	17.5 20.0 35.0	551.1 548.6 533.6	Gravel, pebbles in medium- to coarse-grained sand matrix Top of till Bedrock
I-220 26.0 ft 8/20/65	1 2	0.0 7.0 12.0	26.0 33.0 38.0	542.6 535.6 530.6	Mud, dark-gray, sandy; many small clams and snails Till, yellow-brown with some small angular red gravel, ⅛ inch and smaller Bedrock
P-4 8.5 ft 4/23/62	1 2	0.0-0.5 0.5-26.5 26.5	8.5 9.0 35.0	560.1 559.6 533.6	Sand, fine-grained Till, gray, hard, pebbly Refusal in gravel zone of till
EH-8 2.4 ft 6/3/60	1 2 3 4 5	0.0-0.3 8.4 13.1 18.1 23.1	2.4 10.8 15.5 20.5 25.5	566.2 557.8 553.1 548.1 543.1	Sand, brown, fine-grained Sand, gray, fine-grained, silty Clay, dark-brown, silty, stiff, tenacious, plant-rich Clay, red and gray, mottled, stiff, laminated; few black shell fragments Clay, brown, very hard, pebbly (till?)

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
CP-1	1	0.0	8.1	560.6	Sand, very fine-grained
8.1 ft	2	5.9	14.0	554.6	Lake clay, gray-brown, mottled, stiff
7/31/61	3	6.0-37.4	14.1	554.5	Clay, soft
		37.4-39.9	45.5	523.1	Hard layer, probably top of till
		39.9	48.0	520.6	Bedrock, questionable contact
CP-2	1	0.0	9.5	559.1	Sand, very fine-grained
9.5 ft	2	5.0	14.5	554.1	Sand, fine-grained, silty; shells
8/1/61	3	11.0	20.5	548.1	Sand, gray, fine-grained
		16.0	25.5	543.1	Gravel contact
		16.5	26.0	542.6	Bedrock, questionable contact
CP-3	1	0.0	3.0	565.6	Sand, very fine-grained
3.0 ft	2	7.0	10.0	558.6	Sand, fine-grained with some gravel
8/1/61	3	12.0	15.0	553.6	Sand, fine-grained
	4	14.0-15.0	17.0	551.6	Clay, mixed with gravel
		15.5	18.5	550.1	Bedrock, questionable contact
CP-4	1	0.0	13.0	555.6	Sand, fine- to very fine-grained
13.0 ft	2	2.0	15.0	553.6	Sand
8/1/61	3	7.0	20.0	548.6	Sand, gray, very fine-grained
	4	12.0	25.0	543.6	Sand
	5	17.0	30.0	538.6	Lake clay, reddish-gray, 2 inches; overlain by 2 inches of intermixed clay, coarse sand, and gravel
		22.0	35.0	533.6	Bedrock, questionable contact
CP-5	1	0.0	10.5	558.1	Sand, very fine-grained
10.5 ft	2	4.5	15.0	553.6	Sand, coarse-grained; some fine gravel; shells and clay
8/1/61		6.5	17.0	551.6	Hard layer, probably firm clay
	3	8.0	18.5	550.1	Clay, gray, firm; some sand
		37.5	48.0	520.6	Refusal, probably at top of till
CP-6	1	0.0	7.0	561.6	Sand, very fine-grained
7.0 ft	2	3.5-4.0	10.5	558.1	Silt, brown, compacted
8/2/61	3	8.5	15.5	553.1	Silt, gray, soft, laminated, clay-bonded
	4	13.5	20.5	548.1	Silt, same as sample no. 3, but higher clay content
	5	18.5	25.5	543.1	Silt, same as sample no. 4
	6	23.5	30.5	538.1	Silt, same as sample no. 4
	7	28.5	35.5	533.1	Clay, red, soft; mottled with gray; some sand and shale particles
	8	33.5	40.5	528.1	Clay, red-gray, soft, pebbly
	9	38.5	45.5	523.1	Clay, gray, soft, sandy, silty
	10	43.5	50.5	518.1	Till clay, gray, firm, pebbly
		44.0	51.0	517.6	Bedrock, questionable contact
CP-7	1	0.0	16.5	552.1	Sand, very fine-grained, silty
16.5 ft	2	3.5	20.0	548.6	Sand, very fine-grained, silty
8/2/61		8.5	25.0	543.6	Apparent coarse sand
	3	13.5	30.0	538.6	Clay, gray, soft, laminated
	4	18.5	35.0	533.6	Clay, gray, soft, laminated
	5	23.5	40.0	528.6	Clay, gray, soft; laminated with silt
	6	28.5	45.0	523.6	Clay, red- and gray-mottled, laminated, tenacious; sand particles
		35.0-44.5	51.5	517.1	Hard layer, probably top of till
		44.5	61.0	507.6	Bedrock, questionable contact
CP-8	1	0.0	5.0	563.6	Sand, very fine-grained
5.0 ft	2	5.0	10.0	558.6	Silt, gray and brown, mottled, firm
8/4/61	3	10.0	15.0	553.6	Silt, gray and brown, mottled, firm, clay-bonded
	4	15.0	20.0	548.6	Clay, gray, firm; laminated with silt
	5	20.0-20.5	25.0	543.6	Till clay, gray, firm, pebbly
		35.0	40.0	528.6	Hard layer
		38.5	43.5	525.1	Refusal in hard till clay
CP-9	1	0.0-0.7	7.5	561.1	Peat, black; 4-inch layer overlies soft plastic gray clay
7.5 ft	2	2.5	10.0	558.6	Clay, gray, firm
8/4/61	3	7.5	15.0	553.6	Silt, gray-brown, firm, clay-bonded

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
7301 19.5 ft 10/3/55	1	0.0 14.5	19.5 34.0	549.1 534.6	Mud, mixed with fine-grained sand Refusal in gray clay
7302 20.5 ft 10/3/55	1	0.0 17.0	20.5 37.5	548.1 531.1	Sand, fine-grained Refusal in gray clay
7303 19.1 ft 10/4/55	1 2 3	0.0 17.0 21.5 27.0	19.1 36.0 40.5 56.1	549.5 532.6 528.1 512.5	Sand, fine-grained Sand, hard Mud, mixed with sand and shells Bedrock, questionable contact
7304 18.0 ft 10/4/55	1 2 3 4	0.0 17.0 28.0 33.0 44.0	18.0 35.0 46.0 51.0 62.0	550.6 533.6 522.6 517.6 506.6	Sand, fine- to very fine-grained Sand, hard Sand, mixed with mud, shells Sand, mixed with mud Bedrock, questionable contact
7305 15.5 ft 10/10/55	1 2 3	0.0 21.0 21.1-35.0 35.0	15.5 36.5 36.6 50.5	553.1 532.1 532.0 518.1	Sand, very fine-grained, silty Sand, some clay, shells Sand, clean Bedrock, questionable contact
7306 17.5 ft 10/10/55	1 2 3 4 5 6	0.0 18.0 23.0 28.0 33.0 38.0 41.5	17.5 35.5 40.5 45.5 50.5 55.5 59.0	551.1 533.1 528.1 523.1 518.1 513.1 509.6	Sand, fine- to very fine-grained Sand, fine, clean Sand, fine, clean Sand, clean; some shells Sand, clean; some shells Sand, clean; some shells Bedrock, questionable contact
7307 16.5 ft 10/11/55	1 2 3	0.0 20.0 25.0 38.0	16.5 36.5 41.5 54.5	552.1 532.1 527.1 514.1	Sand, fine- to very fine-grained Sand, few shells Clay, light-gray; sand and shells Bedrock, questionable contact
7308 20.0 ft 10/11/55	1 2	0.0 20.0 35.0	20.0 40.0 55.0	548.6 528.6 513.6	Sand, fine-grained; with silt Clay, gray; overlain by medium-grained sand; shells; wood Bedrock, questionable contact
7309 22.5 ft 10/11/55	1 2	0.0 15.0 32.5	22.5 37.5 55.0	546.1 531.1 513.6	Sand, very fine-grained, silty Clay Bedrock, questionable contact
7310 19.0 ft 10/13/55	1 2	0.0 21.0 25.0	19.0 40.0 44.0	549.6 528.6 524.6	Sand, fine-grained Sand, coarse-grained; some gravel and shells; overlies clay Refusal in clay
7311 15.0 ft 10/17/55	1 2 3	0.0 20.5 23.0 40.5	15.0 35.5 38.0 55.5	553.6 533.1 530.6 513.1	Sand, fine- to very fine-grained Sand, fine-grained; some clay, shells Clay Bedrock, questionable contact
7312 12.5 ft 10/17/55	1 2	0.0 13.0 31.5	12.5 25.5 44.0	556.1 543.1 524.6	Sand, fine- to very fine-grained Sand, very fine-grained Bedrock, questionable contact
7313 23.5 ft 10/27/55	1 2	0.0 15.0 30.5	23.5 38.5 54.0	545.1 530.1 514.6	Sand, very fine-grained, silty Clay Bedrock, questionable contact
7314 20.5 ft 10/27/55	1 2 3	0.0 5.0 15.0 24.0	20.5 25.5 35.5 44.5	548.1 543.1 533.1 524.1	Sand, very fine-grained, silty Sand, green, fine-grained Sand, fine-grained; overlies clay Bedrock, questionable contact

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level	Field description
7315	1	0.0	17.5	551.1	Sand, very fine-grained, silty
17.5 ft	2	18.0	35.5	533.1	Clay, gravelly
10/27/55		20.0	37.5	531.1	Refusal in clay; gravel, shells, and wood in wash
7316	1	0.0	13.5	555.1	Sand, fine- to very fine-grained
13.5 ft	2	19.0	32.5	536.1	Clay
10/27/55		33.0	46.5	522.1	Bedrock, questionable contact
7317	1	0.0	8.0	560.6	Sand, fine-grained
8.0 ft		30.0	38.0	530.6	Lake deposits, abandoned station owing to weather
4/28/56					
7318	1	0.0	8.1	560.5	Sand, very fine-grained, silty
8.1 ft	2	15.0	23.0	545.6	Silt, gritty; fine shell particles
5/1/56	3	20.0	28.0	540.6	Silt, gritty; fine shell particles
	4	25.0	33.0	535.6	Silt, gritty; fine shell particles
		42.0	50.1	518.5	Bedrock, questionable contact
7319	1	0.0	6.5	562.1	Sand, very fine-grained
6.5 ft	2	17.5	24.0	544.6	Clay, gray-brown, moderately stiff
5/1/56		35.0	41.5	527.1	Bedrock, questionable contact
7320	1	0.0	8.4	560.2	Mud, black, silty; some fine-grained sand; decaying odor
8.4 ft	2	5.0	13.5	555.1	Clay, brown; laminated with gray silt, about ten layers per inch
5/1/56		17.0	25.4	543.2	Bedrock, questionable contact
7321	1	0.0	28.9	539.7	Mud, mixed with fine-grained sand
28.9 ft	2	12.0	40.9	527.7	Mud, mixed with fine-grained gray sand
5/15/56	3	17.0	45.9	522.7	Clay, reddish-gray, firm, plastic
		43.0	71.9	496.7	Bedrock, questionable contact
7322	1	0.0	33.7	534.9	Mud, dark-gray
33.7 ft	2	11.0	44.5	524.1	Clay
5/15/56		21.0	54.7	513.9	Bedrock, questionable contact
7323	1	0.0	33.7	534.9	Clay, sandy, pebbly; cobbles
33.7 ft	2	5.0	38.5	530.1	Clay, red, soft
5/15/56	3	17.0	50.5	518.1	Clay, gray, gritty, moderately stiff
		50.0	83.7	484.9	Bedrock, questionable contact
R-748	1	0.0	29.1	539.5	Mud, gray
29.1 ft	2	7.0	36.0	532.6	Sand, green, very fine-grained, silty
10/10/57	3	11.0	40.0	528.6	Clay, gray-brown and pink, laminated
		21.5	50.6	518.0	Bedrock, questionable contact
R-1455	1	0.0	28.1	540.5	Mud, gray; some sand
28.1 ft	2	5.0	33.1	535.5	Clay, brown; organic material
6/10/59	3	7.9	36.0	532.6	Till clay, gray-brown; pebbles
		53.0	81.1	487.5	Bedrock, questionable contact
7120	1	0.0	41.3	527.3	Mud, gray
41.3 ft	2	20.0	61.3	507.3	Silt, gray and brown; laminated with fine-grained sand
10/8/57	3	30.0-42.5	71.3	497.3	Sand, gray, medium-grained, clean
		42.5	83.8	484.8	Bedrock, questionable contact
7121	1	0.0	43.3	525.3	Mud, gray
43.3 ft	2	18.0-18.3	61.3	507.3	Clay, gray-brown, laminated
10/8/57		38.0	81.3	487.3	Top of till
		40.0	83.3	485.3	Bedrock, questionable contact
7122	1	0.0	41.8	526.8	Mud, gray
41.8 ft	2	17.5	59.3	509.3	Clay, gray, lacustrine
10/8/57		33.5	75.3	495.3	Top of till
		37.0	78.8	491.8	Refusal in till

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-1	1	0.0	31.2	531.4	Mud, medium-brown-gray, smooth, silty, slightly gelatinous
31.2 ft	2	3.9-4.9	35.1	533.5	Mud, gray-green, smooth, silty
7/12/68	3	8.9-9.9	40.1	528.5	Mud and peat; upper half of core mud, medium-gray-brown, smooth, coarse, silty; peat, 1-inch layer midcore; lower half of core mud, medium-gray, smooth; fine-grained silt and some clay; many short black streaks
		10.9	42.1	526.5	Upper surface of clay
	4	13.9-14.2	45.1	523.5	Clay, medium-gray-brown, smooth, varved; few black streaks; lake clay
	5	18.9-19.9	50.1	518.5	Clay, upper 0.3 ft of core lake clay, same as sample no. 4; remainder till clay, orange-brown, mottled, variegated; pea-sized gravel
		19.1	50.3	518.3	Upper surface of till clay
		26.2	57.4	511.2	Bedrock
WR-2	1	0.0	30.8	537.8	Mud, medium-gray-brown, smooth, globular
30.8 ft	2	4.6-6.6	35.4	533.2	Mud, medium-gray-brown, smooth; lowest 0.5 ft siltier; shell zone and wood at top of section; black streaks throughout
7/17/68	3	9.6-10.6	40.4	528.2	Silt and clay; silt, medium-brown, coarse; fine plant detritus throughout; clay, light-gray, smooth; black streaks
	4	14.6-15.6	45.4	523.2	Clay, reworked till clay, mottled, smooth; overlying varved medium-gray lake clay
	5	19.6-21.1	50.4	518.2	Clay, reddish-brown, mottled; apparently reworked till clay
	6	24.1-24.2	54.9	513.7	Clay, dark-gray; gravel; apparently "hardpan"
		25.1	55.9	512.7	Upper surface of till clay
		28.1	58.9	509.7	Bedrock
WR-3	1	0.0	29.4	539.2	Mud, medium-gray-brown, smooth, globular
29.4 ft	2	5.6-7.6	35.0	533.6	Mud, medium-gray, smooth; shell detritus zone 0.2 ft above base; lowest 0.2 ft silt, medium-brown, smooth
7/17/68	3	10.6-11.6	40.0	528.6	Clay, medium-gray, smooth, fairly stiff; many shell fragments
	4	15.6-18.6	45.0	523.6	Lake clay, gray-green, smooth, slightly varved
	5	20.6-22.2	50.0	518.6	Lake clay, smooth, varved; light-gray and dark-yellow-gray bedding; center 8 inches of core apparently layered re-worked glacial till clay
	6	25.6-27.5	55.0	513.6	Clay, gray; mottled with orange; few pieces of small gravel; apparently reworked till clay
		30.3	56.7	511.9	Upper surface of till clay
		30.6	60.0	508.6	Till clay
		33.1	62.5	506.1	Bedrock
WR-4	1	0.0	29.2	539.4	Mud, medium-gray, smooth, very gelatinous; few black streaks
29.2 ft					
7/17/68	2	5.7-7.2	34.9	533.7	Mud, medium-gray-brown, smooth, silty; shell detritus zone 0.5 ft above base; lowest 0.5 ft of core lake clay, silty; varved with black streaks and plant detritus
	3	10.7-12.2	39.9	528.7	Lake clay, medium- to light-gray, varved; alternating color bands, mostly light-yellow to cream
	4	15.7-17.2	44.9	523.7	Till clay, reddish-brown, mottled; coarse sand and pea-sized gravel; uppermost 0.5 ft of core apparently reworked till clay
		16.2	45.4	523.2	Upper surface of till clay
		32.7	61.9	506.7	Bedrock
WR-5	1	0.0-0.4	27.8	540.8	Mud, gray-brown, silty, soft
27.8 ft	2	6.9-7.5	34.7	533.9	Woody material and clay; upper 0.1 ft well-preserved wood; lower 0.5 ft gray-brown clay grading to red brown at base; stiff; compact; black streaks throughout
8/7/68	3	11.9-13.4	39.7	528.9	Clay, gray-brown, stiff; very fine laminations in upper half; mottled with red and blue-gray pods toward base
	4	16.9-18.6	44.7	523.9	Clay, reddish-brown, moderately soft; mottled with red and blue-gray pods; ½ inch pebbles at base
		19.4	47.2	521.4	Hard layer, probably pebble-rich till
		21.2	49.0	519.6	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-6 29.5 ft 7/17/68	1	0.0	29.5	539.1	Mud, medium-gray-brown, smooth, slightly gelatinous
	2	5.5-7.0	35.0	533.6	Mud, peat, and clay; mud, light-gray-brown, smooth; 0.5 ft peat, dark-brown, silty; much plant detritus; thin shell zone at base; clay, light-gray-green, smooth; some varving; few black streaks
	3	10.5-11.0	40.0	528.6	Lake clay, medium-brown-gray, smooth; many small black spots
	4	15.5-16.5	45.0	523.6	Lake clay; clay, medium-gray, smooth, varved; immediately overlying reworked till clay interlayered with lake clay
	5	20.5-22.0	50.0	518.6	Till clay, reworked, mottled, streaked; gravel, overlying medium-gray-brown lake clay
		23.5	53.0	515.6	Bedrock
WR-7 30.0 ft 7/15/68	1	0.0	30.0	538.6	Mud, medium-gray, slightly globular, very watery; light brown on surface
	2	5.2-7.2	35.2	533.4	Mud, upper half medium gray, fine grained; lower half coarse gray-brown silt overlain by thin shell detritus zone
	3 3A	10.2-12.2	40.2	528.4	Silt, peat, and clay; silty dark-brown mud, rich in plant detritus; lowest 0.5 ft rich plant detritus zone; lowest 0.1 ft varved black lake clay
	4	15.2-16.4	45.2	523.4	Clay, light-brown-gray, smooth; scattered black streaks
	5	20.2-23.2	50.2	518.4	Till clay, red-brown, mottled, variegated; gravel and coarse sand
		20.5	50.5	518.1	Upper surface of till
		27.2	57.2	511.4	Bedrock, questionable contact
WR-8 30.7 ft 8/1/68	1	0.0-0.5	30.7	537.9	Mud, gray-brown, smooth, silty; thin oxidized brown layer at surface
	2	3.5-4.8	34.2	534.4	Clay, upper 0.8 ft smooth, gray, soft; lower 0.5 ft stiffer, dark brown; shell fragments in lower part
8/2/68	3A 3B	7.0-8.1 7.0-7.9	37.7	530.9	Clay and peat; uppermost 0.2 ft smooth gray-brown clay; underlain by 0.6 ft stiff brown clay with shell fragments; underlain by 0.1 ft of well-preserved wood; lowest 0.2 ft peat material, dark-brown plant detritus, shell fragments
	4	9.0-9.7	39.7	528.9	Clay and wood; upper 0.5 ft gray-brown clay; lower 0.2 ft well-preserved wood
	5	13.3-14.1	44.0	524.6	Clay, gray, firm; few small pebbles; probably glacial lake clay
	6	18.8-20.8	49.5	519.1	Clay, gray, smooth; few small pebbles
	7	23.8-25.5	54.5	514.1	Clay, upper 0.8 ft smooth finely laminated gray clay; lower 0.9 ft gray clay mottled with red and blue-gray lenses
	8	28.8-30.3	59.5	509.1	Clay, same as lower unit of sample no. 7, with some fine sand and angular pebbles
	9	33.8-35.4	64.5	504.1	Till clay, gray clay with very fine sand to 1-inch diameter pebbles; probably reworked or waterlain
		37.8	68.5	500.1	Hard layer
		46.3	77.0	491.6	Bedrock
					(Return to WR-8 for additional peat material)
WR-8A 30.7 ft 8/8/68	1	3.9-5.6	34.6	534.0	Clay, gray-brown; watery silty clay grading down to peaty material
	2	6.2-8.6	36.9	531.7	Clay and peat; 0.2 ft of gray-brown clay at top with peaty material below
	3	8.7-9.7	39.4	529.2	Clay and peat; uppermost 0.2 ft watery silty gray-brown clay; middle 0.4 ft peaty material; lowest 0.3 ft compact gray clay
WR-9 25.2 ft 8/7/68	1	0.0-0.4	25.2	543.4	Mud, gray-brown, smooth, soft; thin oxidized layer at surface
		4.0	29.2	539.4	Apparent sand layer
	2	4.5-4.8	29.7	538.9	Till clay, gray-brown; rich in fine-grained pebbles
	3	9.0-9.3	34.2	534.4	Till clay, same as sample no. 2
		15.1	40.3	528.3	Bedrock
WR-10 20.9 ft 8/5/68	1	0.0-0.1	20.9	547.7	Sand and gravel; lag sand and gravel up to ½ inch in size over reworked till
		0.1-1.7	22.7	545.9	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-11 25.1 ft 7/11/68	1	0.0	25.1	543.5	Mud, medium-gray-brown; slight plasticity; pea-sized gravel
	2	4.5-5.5	29.6	539.0	Mud and sand; mud, same as sample no. 1; sand, fine-grained; small shell fragments throughout sand; lowest 0.1 ft very fine sand and silt
	3	9.5-10.2	34.6	534.0	Silt, medium-gray-brown; few black streaks; slight clay content
	4	14.5-15.0	39.6	529.0	Clay, medium-brown, thinly varved, very dense; some black bands
	5	19.5-20.0	44.6	524.0	Clay, same as sample no. 4, but without black bands
	6	24.5-25.5	49.6	519.0	Clay, same as sample no. 5
	7	29.5-30.5	54.6	514.0	Clay and till clay; clay same as sample no. 5; grading into till clay in middle of core
		40.5	65.6	503.0	Bedrock
WR-12 23.2 ft 7/12/68	1	0.0	23.2	545.4	Mud, medium-gray, smooth, gelatinous, globular
	2	1.7-2.7	24.9	543.7	Mud, medium-gray-green, smooth, silty
	3	6.7-7.7	29.9	538.7	Mud and sand; mud, same as sample no. 2; sand and shell detritus zone in middle of core; sand in lower 0.5 ft
	4	11.7-12.7	34.9	533.7	Sand and silt; sand, medium- to fine-grained; alternating 0.1-ft beds of sandy medium-gray-green silt
	5	16.7-17.7	39.9	528.7	Sand and clay; sand, medium-grained, silty; bottom 0.1 ft apparently high in clay content
		18.7	41.9	526.7	Stiffer zone
	6	21.7-22.7	44.9	523.7	Sand and clay; medium-grained sand mixed with medium-gray-brown silty clay
		24.7	47.9	520.7	Upper surface of till, "hardpan"
	7	26.7-27.7	49.9	518.7	Till clay, medium-gray; gravel up to ⅜ inch in diameter; apparently weathered till or "hardpan"
		36.7	59.9	508.7	Refusal in extremely hard and sticky clay; believed to be in uppermost "weathered" zone of bedrock
WR-13 19.6 ft 6/20/68	1	0.0-0.5	19.6	549.0	Mud, gray-brown, silty
	2	7.8-8.9	25.4	543.2	Lake clay, medium-gray, smooth, soft; shell fragments at base; slightly gritty at base
	3	8.9-9.0	26.5	542.1	Lake clay, gray-brown, firm; thin black bands
	4	9.0-9.1	26.6	542.0	Wood, brown; fragments interbedded with clay
	5	9.1-9.3	26.7	541.9	Lake clay, same as sample no. 3
	6	10.8-11.2	30.4	538.2	Clay, gray-brown; light-gray bands, approximately 6 sets/inch; abundant globules of black material
		12.8	32.4	536.2	Hard layer
	7	15.8-16.1	35.4	533.2	Clay (glaciolacustrine), gray-brown, firm, dense; similar to sample no. 6 but fewer black globules
	8	19.8-20.5	39.4	529.2	Clay, gray-brown, firm; red mottling; pebbles (reworked till?)
		22.8	47.4	521.2	Hard layer (top of till?)
	9	29.0	48.6	520.0	Bedrock; wash, mostly coarse-sand-sized black shale particles
WR-14 12.0 ft 7/18/68	1	0.0	12.0	556.6	Sand and gravel; sand, coarse-grained; gravel up to 1 inch in diameter
	2	0.5-1.0	12.5	556.1	Clay, reworked till clay; "hardpan" overlain by lag deposits of sand and gravel
		3.2	15.2	553.0	Upper surface of till clay (apparent)
		15.8	27.8	540.8	Bedrock
WR-15 28.1 ft 7/11/68	1	0.0	28.1	540.5	Mud, dark-gray-brown, smooth, slightly gelatinous
	2	6.6-7.6	34.7	533.9	Silt, medium-gray-brown, smooth; fine-grained on top; grading down to fine sand zone with shells
		9.6	37.7	530.9	Hard layer, apparently sand
	3	11.6-12.5	39.7	528.9	Silt, medium-gray-brown; fine silt mixed with very fine sand; few pieces small gravel and 1¼-inch pebbles
	4	16.6-17.6	44.7	523.9	Clay, orange-brown, slightly horizontally banded, smooth; uniform entire core length; apparently lacustrine
	5	21.6-22.6	49.7	518.9	Clay, same as sample no. 4
	6	26.6-27.6	54.7	513.9	Till clay, red-orange-brown, mottled, variegated; upper 3 inches of core dark orange brown; much gravel in uppermost 0.1 ft
		34.6	62.7	505.9	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-16 31.9 ft 7/8/68	1	0.0	31.9	536.7	Mud, medium-gray-brown, smooth, gelatinous; few pea-sized pieces angular gravel
	2	3.3-5.3	35.2	533.4	Mud and clay; mud, light- to dark-brown; bottom 1 inch of sample clay, variegated, smooth; apparently till clay
		5.3	37.2	531.4	Upper surface of till clay
	3	8.3-8.8	40.2	528.4	Till clay, variegated, dense, stiff; few pieces pea-sized gravel spread throughout
		19.3	51.2	517.4	Bedrock, questionable, but apparently within few inches above contact
WR-17 27.7 ft 10/23/67	1	0.0-0.5	27.7	540.9	Mud, gray-brown, silty
	2	3.5-4.5	31.2	537.4	Clay, gray-brown, silty; 0.2 ft watery zone at base containing mollusk shells
		7.5	35.2	533.4	Hard layer, probably till clay
	3	8.5-8.8	36.2	532.4	Till clay, hard; red and bluish-gray pods in gray-brown matrix
		10.5	38.2	530.4	Soft layer (lake clay?)
		20.5	48.2	520.4	Hard layer (till clay?)
		24.6	52.3	516.3	Bedrock
WR-18 9.5 ft 7/31/68	1	0.0-0.1	9.5	559.1	Sand, brown, medium-grained; angular pebbles
	2	0.1-0.5	9.6	559.0	Till clay, brown, hard; mottled with red and bluish gray; numerous angular pebbles
	3	1.3-1.6	10.8	557.8	Till clay, same as sample no. 2
		10.9	20.4	548.2	Bedrock
WR-19 22.2 ft 10/23/67	1,2,3	0.0-0.5	22.2	546.4	Sand, upper 0.2 ft brown, clean, coarse grained; lower 0.3 ft gray, fine grained, with few pebbles; thin black carbonaceous layer between
	4,5	4.0-5.7	26.2	542.4	Clay, upper 0.7 ft gray, with thin zone of coarse-grained sand at top; lower 1.0 ft gray brown
		8.0	30.2	538.4	Hard layer, probably till clay
	6	9.0-9.2	31.2	537.4	Till clay, gray-brown, hard; small pebbles
		17.0	39.2	529.4	Bedrock
WR-20 32.0 ft 7/8/68	1	0.0	32.0	536.6	Mud, medium-gray-brown, smooth, slightly gelatinous; slight plasticity; globules throughout
	2	3.2-5.2	35.2	533.4	Mud, light-brown upper zone, yellow-brown lower zone; gravel and shell zone at base
		5.2	37.2	531.4	Till clay, upper surface
	3	8.2-9.2	40.2	528.4	Till clay, variegated; small amount of $\frac{1}{16}$-inch gravel
		17.2	49.2	519.4	Bedrock
WR-21 18.7 ft 10/23/68	1	0.0-0.3	18.7	559.8	Sand, brown, medium- to coarse-grained, in upper 0.2 ft; with small pebbles; lower 0.1 ft gray-brown till clay with pebbles
	2	1.5-1.8	20.2	548.4	Till clay, gray, hard; pebbles
		19.8	38.5	530.1	Bedrock
WR-22 10.2 ft 10/2/67	1	0.0-0.3	10.2	558.4	Sand, medium-brown, coarse-grained, in upper 0.2 ft; with pea-sized gravel; lower 0.1 ft hard gray-brown till clay
		14.5	24.7	543.9	Bedrock
WR-23 7.7 ft 10/2/67	1	0.0-0.2	7.7	560.9	Till clay, gray-brown, hard; pebbles
		3.5	11.2	557.4	Bedrock
WR-24 16.4 ft 9/8/67	1	0.0-0.3	16.4	552.2	Sand, medium- to fine-grained; over till clay
	2	0.3-0.5	16.7	551.9	Till clay, medium-brown, hard; sand and gravel
	3	4.5-6.0	20.9	547.7	Till clay, gray-brown to pink, pebble-rich
	4	9.5-9.6	25.9	542.7	Till clay, gray-brown to pink, pebble-rich
		11.0	27.4	541.2	Hard layer
		15.5	31.9	536.7	Bedrock
WR-25 17.7 ft 9/8/67	1	0.0-0.1	17.7	550.9	Sand and gravel, rich in crystalline rocks
	2	0.1-0.3	17.8	550.8	Till clay, gray-brown, hard; with sand and gravel
	3	1.7-2.0	19.4	549.2	Till clay, gray-brown, hard; with sand and gravel
		15.7	33.4	535.2	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-26	1	0.0-0.4	22.5	546.1	Mud, dark-gray, smooth
22.5 ft	2	3.2-4.5	25.7	542.9	Clay, medium-gray, plastic
8/29/67	3	8.5-8.8	31.0	537.0	Till clay, reddish-brown, hard, gritty
		30.7	53.2	515.4	Bedrock
WR-27	1	0.0-0.4	24.4	544.2	Mud, dark-gray, silty, smooth
24.4 ft	2	6.6-7.3	31.0	537.6	Clay, medium- to light-gray, plastic
8/29/67	3	11.6-12.6	36.0	532.6	Sand, fine-grained, silty; 0.1 ft sandy clay at base
	4	16.1-16.5	40.5	528.1	Clay, reddish-brown, stiff; appearance of reworked till
		42.1	66.5	502.1	Refusal in gravel layer, probably till
WR-28	1	0.0-0.4	25.5	543.1	Mud, medium-gray, smooth, silty
25.5 ft	2	5.0-6.1	30.5	538.1	Clay, medium-gray, plastic
8/29/67	3A	10.4-11.2	35.9	532.7	Silt, medium-brown; plant material
	3B	11.2-12.0	36.7	531.9	Silt, medium-brown; plant material and clam shells
	4	15.3-16.4	40.8	527.8	Silt, yellow-brown; slight organic content
	5	20.0-20.8	45.5	523.1	Clay, light-gray, smooth, plastic
	6	25.5-26.6	51.0	517.6	Till clay, medium-gray to pink, gritty
	7	30.0-30.3	55.5	513.1	Till clay, medium-gray to pink, gritty
		39.5	65.0	503.6	Refusal in gravel layer
WR-29	1	0.0-0.4	26.5	542.1	Mud, dark-gray, smooth
26.5 ft	2	4.4-5.2	30.9	537.7	Clay, medium- to light-gray; appearance of reworked till
8/30/67	3	8.9-9.3	35.4	533.2	Till clay, medium-gray, hard; pebbles
		30.1	56.6	512.0	Bedrock
WR-30	1	0.0-0.3	28.2	540.4	Mud, medium-gray, smooth
28.2 ft	2	3.5-4.0	31.7	536.9	Mud, light-gray, smooth
8/2/68	3	6.3-6.9	34.5	534.1	Clay, mottled with red, blue, and gray brown; few small pebbles
		9.3	37.5	531.1	Hard layer, probably glacial till
	4	11.3-11.7	39.5	529.1	Till clay, gray-brown, very hard; pebbles
		14.3	42.5	526.1	Gravel zone within till
		39.4	67.6	501.0	Bedrock, questionable contact
WR-31	1	0.0-0.4	30.4	538.2	Mud, medium-gray, highly plastic; light-brown surface; small globules in upper portion
30.4 ft					
9/25/67	2	5.7-6.3	36.1	532.5	Mud, upper 0.5 ft light gray, smooth, with small snail shells; lower 0.1 ft dark red brown, silty, plastic, fluffy
	3	10.7-11.7	41.1	527.5	Peat, dark-red-brown, highly organic; light-gray clay in lowest 0.1 ft
	4	15.7-16.0	46.1	522.5	Till clay, medium-gray, very stiff; pink mottling throughout; small angular gravel
		36.7	67.1	501.5	Bedrock
WR-32	1	0.0-0.4	30.5	538.1	Mud, light- to medium-gray, smooth
30.5 ft	2	5.6-6.5	36.1	532.5	Mud, medium-gray, smooth, in upper 0.5 ft; lower 0.4 ft peaty material, dark-red-brown, fluffy, with shell fragments
9/25/67					
	3	10.6-11.0	41.1	527.5	Peat, medium-brown to red-brown, silty, highly organic
	4	15.6-15.19	46.1	522.5	Till clay, slightly gritty, stiff; light-gray-brown matrix with pink mottling
		41.3	70.8	496.8	Bedrock
WR-33	1	0.0	31.2	537.4	Mud, gray-brown, smooth
31.2 ft	2	0.0-2.0	33.2	535.4	Mud, gray-brown, smooth
10/4/67	3	5.0-6.0	37.2	531.4	Mud, gray-brown, silty in upper 0.5 ft; lower 0.5 ft brown plant material with shells, silty
	4	10.0-11.0	42.2	527.4	Peat, red-brown in upper 0.8 ft; lower 0.2 ft firm gray clay
		13.0	44.2	524.4	Hard layer, probably top of till
	5	14.5-15.0	46.2	522.9	Till clay, gray, hard; pebbles and black shale fragments
		35.0	66.2	502.4	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-34	1	0.0-0.4	31.6	537.0	Mud, medium-gray, smooth
31.6 ft	2	4.5-5.5	36.1	532.5	Mud, upper 0.8 ft medium to dark gray, smooth; lower 0.2 ft light gray, slightly sandy; shell fragments
10/5/67	3	9.5-10.2	41.1	527.5	Clay and peat; upper 0.4 ft clay, medium-gray to brown, slightly sandy, plastic; lower 0.3 ft peat, red-brown, highly organic
	4	14.5-15.1	46.1	522.5	Till clay, medium-gray, gritty, very stiff, hard; mottled with pink and black inclusions
		17.5	49.1	519.5	Hard layer
		34.5	66.1	502.5	Bedrock
WR-35	1	0.0-0.4	32.0	536.6	Mud, medium- to dark-gray, smooth, very fluid; light brown on surface
32.0 ft					
10/5/67	2	4.0-4.9	36.0	532.6	Mud, medium- to light-gray, smooth, sandy; shell fragments
	3	9.0-9.9	41.0	527.6	Mud, peat, and till clay; uppermost 0.6 ft mud, light-gray, smooth; narrow shell zone at top; middle 0.2 ft peat, red-brown, highly organic; lowest 0.1 ft reworked till clay, smooth; slightly gradational with overlying peat
	4	14.0-14.5	46.0	522.6	Till clay, medium-gray, very stiff; pink cast
		35.7	67.7	500.9	Bedrock
WR-36	1	0.0	32.0	536.6	Mud, medium-gray-brown, slightly plastic, smooth
32.0 ft	2	7.5-9.0	39.5	529.1	Mud, medium-gray-brown, highly plastic, smooth
7/8/68	3	13.0-13.8	45.0	523.6	Mud and clay; mud, light-gray-brown, smooth; overlying 0.2 ft of clay with distinct contact; clay, very firm, dense; some black streaks; apparently reworked till clay
		41.0	73.0	495.6	Bedrock
WR-37	1	0.0-0.4	28.1	540.5	Mud, dark-gray-brown, silty; small clam and snail shells
28.1 ft	2A	3.5-4.0	31.6	537.0	Clay, dark-gray, soft
6/2/67	2B	4.0-4.5			Clay, reddish-brown, gritty, compact; black streaks; probably reworked till
	3	7.0-7.3	35.1	533.5	Till clay, brown, hard; angular gravel
		7.7	35.8	532.8	Bedrock
WR-38	1	0.0-0.4	28.2	540.4	Mud, dark-gray-brown, watery
28.2 ft	2A	3.5-4.5	31.7	536.9	Clay, gray, smooth
6/2/67	2B	4.5-5.5			Clay, gray, smooth
	2C	5.5-6.5			Clay, gray, watery
		6.7	34.9	533.7	Hard layer, possibly top of till
	3	8.5-8.9	36.7	531.9	Till clay, brown; fine-grained sand and gravel
		13.5	41.7	526.9	Bedrock
WR-39	1	0.0-0.4	27.7	540.9	Mud, dark-gray-brown, light-brown
27.7 ft	2A	3.4-4.3	31.1	537.5	Clay, gray, smooth
6/5/67	2B	4.3-5.1			Clay, gray, smooth
	2C	5.1-5.9			Clay, gray, smooth, watery
		7.5	35.2	533.4	Hard layer, compact clay zone
	3	8.2-9.2	35.9	532.7	Clay, gray-brown, hard, compact, gritty; red pods; probably reworked till
		9.5	37.2	531.4	Hard layer, probably till
	4	13.4-14.1	41.1	527.5	Till clay, gray-brown; pebbles
		19.4	47.1	521.5	Bedrock
WR-40	1	0.0-0.4	27.9	540.7	Mud, dark-gray-brown, watery
27.9 ft	2A	3.2-4.6	31.1	537.5	Clay, gray-brown; watery zone near top, firmer toward base
6/5/67	2B	4.6-5.0			Clay, gray-brown, firm, gritty; shell fragments
	3A	7.7-8.1	35.6	533.0	Clay, gray-brown, firm
	3B	8.1-8.7			Till clay, gray-brown, gritty, hard; red and blue-gray pods
	4	12.0-12.4	39.9	528.7	Till clay, brown, hard; angular pebbles
		15.1	43.0	525.6	Bedrock
WR-41	1	0.0-0.2	13.8	554.8	Sand, medium-brown, fine- to coarse-grained, silty; pebbles; overlying glacial till clay
13.8 ft					
10/2/67		0.3	14.1	554.5	Hard layer, top of till clay
		9.4	23.2	545.4	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-42	1	0.0-0.3	15.4	553.2	Sand, medium-brown, fine-grained
15.4 ft		3.0	18.4	550.2	Harder layer, probably top of till clay
10/31/67	2	5.5-5.8	20.9	547.7	Till clay, medium-gray, stiff; pink cast; pea-sized gravel
		19.0	34.4	534.2	Refusal in hard till clay
WR-43	1	0.0-0.2	2.6	566.0	Sand, medium-brown, fine-grained, clean
2.6 ft	2	2.9-3.4	5.5	563.1	Sand, medium-brown, coarse-grained, in upper 0.3 ft; lower 0.2 ft dark-gray silty peat
9/19/67	3	7.6-8.1	10.2	558.4	Gravel, fine-grained to $\frac{3}{8}$-inch diameter; over dark-gray silty peat
	4	12.9-13.4	15.5	553.1	Gravel, fine-grained to $\frac{3}{8}$-inch diameter; over dark-gray silty peat
	5	17.4-17.8	20.0	548.6	Peat, brown, silty; small snail and clam shells
	6	19.9	22.5	546.1	Clay, light-gray; mixed with gravel and wood particles in wash; refusal in gravel layer
WR-44	1	0.0-0.2	13.4	555.2	Sand, medium-brown, fine-grained, silty
13.4 ft	2	1.8-2.1	15.2	553.4	Till clay, brown, hard, gritty
9/19/67		3.7	17.1	551.5	Bedrock
WR-45	1	0.0-0.2	14.8	553.8	Sand, medium-brown, fine-grained, silty
14.8 ft	2	0.8-1.1	15.6	553.0	Till clay, light-brown, hard; pebbles
9/19/67		5.5	20.3	548.3	Bedrock
WR-46	1	0.0-0.3	22.4	546.2	Sand, medium-brown; mixed with dark-gray silty mud
22.4 ft	2	4.0-5.1	26.4	542.2	Clay, medium-gray, smooth, plastic
10/31/67	3	9.0-9.3	31.4	537.2	Till clay, medium-gray, hard; pink cast; pea-sized gravel
		30.5	52.9	515.7	Bedrock
WR-47	1	0.0-0.4	25.4	543.2	Mud, dark-gray, smooth, silty
25.4 ft	2	6.0-6.3	31.4	537.2	Till clay, light-gray, hard; mottled with pink
10/31/67		20.0	45.4	523.2	Refusal in sticky till clay
WR-48	1A	0.0-0.1	28.2	540.4	Mud, medium-brown, smooth
28.2 ft	1B	0.1-0.4			Mud, dark-gray-brown
6/6/67	2A	1.6-2.2	29.8	538.8	Clay, gray-brown
	2B	2.2-2.4			Clay, gray-brown, firm; numerous shell fragments
	3A	2.4-2.8	30.6	538.0	Clay, gray-brown, soft
	3B	2.8-3.2			Clay, gray-brown, smooth, watery
	3C	3.2-4.5			Clay, gray, smooth, soft
	3D	4.5-4.8			Clay, light-gray, firm; shell fragments and fine laminations
	3E	4.8-5.4			Clay, gray-brown, very soft to watery
		6.4	34.6	534.0	Hard layer, compact clay
	4A	7.4-8.3	35.6	533.0	Clay, brown, compact
	4B	8.3-8.6			Clay, brown, hard; red pods; possibly reworked till
		8.4	36.6	532.0	Harder layer, till
	5	12.1-13.4	40.3	528.3	Till clay, brown, hard; red and light-brown and gray pods; angular pebbles
		15.4	43.6	525.0	Bedrock
WR-49	1	0.0-0.4	27.9	520.7	Mud, dark-gray-brown, clayey
27.9 ft	2A	3.2-4.0	31.1	537.5	Clay, gray-brown, soft, smooth
6/8/67	2B	4.0-4.4			Clay, gray-brown, compact
	2C	4.4-4.7			Clay, dark-gray-brown, firm, gritty
	2D	4.7-4.9			Clay, gray-brown, watery
	3A	7.7-8.0	35.6	533.0	Clay, light-brown-gray, compact; blue-gray streaks
	3B	8.0-8.3			Clay, gray, hard; red streaks and pods
		8.7	36.6	532.0	Hard layer, probably top of till
	4	12.7-13.3	40.6	528.0	Till clay, brown, red-mottled, hard, gritty
	5	15.2-15.7	43.1	525.5	Till clay, brown-gray, hard; angular pebbles
		19.8	47.7	520.9	Bedrock
WR-50	1	0.0-0.1	20.0	548.6	Sand, medium- to coarse-grained; mixed with pebbles and shell fragments
20.0 ft					
6/14/67	2	0.1-0.6	20.1	548.5	Till clay, gray-brown, hard; angular pebbles; thin reddish-brown clay layer near top
	3	0.8-1.3	20.8	547.8	Till clay, light-brown, hard; angular pebbles
		8.1	28.1	540.5	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-51	1	0.0-0.4	22.9	545.7	Mud, dark-gray, smooth, silty
22.9 ft	2	3.5-4.6	26.4	542.2	Clay, medium-gray-brown, plastic; black inclusions; plant material
10/11/67	3	8.5-9.3	31.4	537.2	Clay, light-brown to gray, sandy, stiff
	4	13.5-13.8	36.4	532.2	Clay, light-brown to gray, sandy, stiff, dry
	5	18.0-19.0	40.9	527.7	Till clay, medium-brown, hard, stiff; pink cast
		36.5	59.4	509.2	Bedrock
WR-52	1	0.0-0.4	25.0	543.6	Mud, dark-gray, gritty, silty
25.0 ft	2	6.0-7.8	31.0	537.6	Mud, dark-gray, silty; shells
8/21/67	3	10.8-12.6	35.8	532.6	Clay, gray to pink; gravel and plant material
	4	15.8-16.1	40.8	527.6	Till clay, gray to pink, hard, dry
	5	20.8-22.2	45.8	522.6	Till clay, light-brown, hard, smooth; pink cast
		31.9	56.9	511.7	Bedrock
WR-53	1	0.0-0.4	15.7	552.9	Mud, dark-gray, silty, sandy
15.7 ft		2.0	17.7	550.9	Sand layer
8/24/67	2	3.9-4.2	19.6	549.0	Till clay, light-gray, gritty; mottled with red-brown
		8.9	24.6	544.0	Gravel layer
		13.9	29.6	539.0	Gravel layer
		15.2	30.9	537.7	Bedrock
WR-54	1	0.0-0.1	14.3	554.3	Sand, coarse-grained; snail shells
14.3 ft	2	0.1-0.3	14.5	554.1	Till clay, gray-brown, hard; pebbles
10/3/68		12.0	26.3	542.3	Bedrock
WR-55	1	0.0-0.4	21.1	547.5	Mud, medium-gray-brown, smooth
21.1 ft	2	5.0-7.3	26.1	542.5	Mud, light-gray, smooth, in upper 2.0 ft; lower 0.3 ft hard gray clay, slightly gritty, with thin sand layer at top
9/18/67	3	10.0-11.0	31.1	537.5	Till clay, gray, hard; pea-sized gravel
		14.0	35.1	533.5	Refusal in gravel layer
WR-56	1	0.0-0.4	20.2	548.4	Mud, dark-gray, smooth; brown surface
20.2 ft	2A	5.6-6.1	25.8	542.8	Mud, light-gray, smooth, tacky
9/18/67	2B	6.1-6.3	26.3	542.3	Till clay, gray to pink, hard, gritty; thin sand layer at top
	3	10.4-10.7	30.6	538.0	Till clay, gray to pink, hard, dry, gritty
	4	17.4	37.6	531.0	Gravel, wash sample of pea-sized gravel to fine-grained sand
		29.4	49.6	519.0	Refusal in gravel layer
WR-57	1	0.0-0.4	19.5	549.1	Mud, medium-gray-green, smooth
19.5 ft		5.1	24.6	544.0	Sand and gravel layer
9/18/67	2	6.1-6.4	25.6	543.0	Clay, gray, dry; pink cast; plant material; possibly reworked till
	3	9.9-10.2	29.4	539.2	Till clay, light-brown, hard; pink cast; fine-grained gravel
	4	12.9	32.4	536.2	Sand, wash sample of coarse-grained sand
		20.1	39.6	529.0	Bedrock
WR-58	1	0.0-0.4	17.9	550.7	Mud, medium- to dark-gray, smooth
17.9 ft	2	2.7-3.2	20.6	548.0	Clay, medium-gray-green, sandy; plant material
9/18/67	3	7.7-8.0	25.6	543.0	Clay, yellow-brown, hard, dry; plant material
	4	12.7-13.5	30.1	538.0	Till clay, gray, hard, gritty
		16.2	34.1	534.5	Gravel layer
		19.2	37.1	531.5	Bedrock
WR-59	1	0.0-0.3	16.8	551.6	Mud, dark-gray, sandy
16.8 ft	2	4.3-4.6	21.1	547.5	Clay, yellow-brown, hard, gritty; probably reworked till
9/19/67		8.3	25.1	543.5	Harder layer, till
		13.8	30.6	538.0	Bedrock
WR-60	1	0.0-0.4	14.4	554.2	Mud, dark-gray, silty; brown surface
14.4 ft	2	6.2-6.4	20.6	548.0	Till clay, medium-brown, hard; pebbles
9/19/67		10.6	25.0	543.6	Bedrock

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
WR-61 27.9 ft 3/21/67	1	0.0-0.3	27.9	540.7	Mud, dark-gray, smooth; brown surface
	2	3.0-6.0	30.9	537.7	Clay, medium- to light-gray, plastic; grading to stiff sandy clay at base
	3	7.5-7.8	35.4	533.2	Till clay, light-gray-brown; pink cast; pea-sized gravel
		15.0	42.9	525.7	Bedrock
WR-62 31.5 ft 8/25/67	1	0.0-0.4	31.5	537.1	Mud, medium- to dark-gray, silty
	2	5.0-6.5	36.5	532.1	Mud, medium-gray, smooth; grading to light-red-brown plastic clay in lowest 0.5 ft; slightly sandy
	3	8.6-9.0	40.1	528.5	Clay, light-gray; pink cast; fine-grained gravel; probably reworked till
	4	13.7-14.0	45.4	523.2	Till clay, medium-gray; pink cast; angular pea-sized gravel
		30.2	61.7	506.9	Bedrock
WR-63 24.0 ft 10/1/69	1	0.0-0.4	24.0	544.6	Mud, gray-brown, silty; very fluid at surface
	2	4.7-5.2	28.7	539.9	Silt, gray-brown, compact; very fine sand at top
		5.3	29.3	539.3	Bedrock, thin gravel layer above
WR-64 24.3 ft 10/1/69	1	0.0-0.4	24.3	544.3	Mud, gray-brown, fluid, sandy
	2A	4.9-5.1	29.2	539.4	Sand, fine-grained; small snail shells
	2B	5.1-5.3			Silt, gray-brown, sandy; shells and plant detritus
	3	10.6-10.8	34.9	533.7	Sand, gray-brown, fine-grained, silty; snail and clam shells; wood chips
	4	15.6-16.3	39.9	528.7	Sand, gray-brown, fine-grained, silty; shell fragment layer in top 0.2 ft
		18.6	42.9	525.7	Harder layer, probably top of clay
	5	19.9-20.7	44.2	524.4	Clay, gray, hard, compact; red mottling (modified till?)
	6	25.6-25.7	49.9	518.7	Clay, light-gray, hard, compact (till?)
		40.4	64.7	503.9	Bedrock
WR-65 2.3 ft 10/2/69	1	0.0-0.2	2.3	566.3	Sand, brown, fine-grained, clean
	2A	3.8-5.1	6.1	562.5	Sand, gray-brown, medium-grained, silty; plant detritus
	2B	5.1-5.4			Clay, gray, hard, compact
	3	10.0-10.3	12.3	556.3	Till clay, light-gray, hard; pebbles
		12.5	14.8	553.8	Bedrock
WR-66 6.0 ft 10/2/69	1	0.0-0.2	6.0	562.6	Sand, brown, fine-grained, silty
	2A	3.6-3.8	9.6	559.0	Sand, gray-brown; mixed with silt, clay, and shells
	2B	3.8-4.1			Clay, gray-brown, hard; mottled with red bands and pods; snail shells at top; bottom 0.1 ft modified till clay
		6.3	12.3	556.3	Bedrock
WR-67 7.5 ft 10/8/69	1	0.0-0.3	7.5	561.1	Sand, brown, medium- to fine-grained, clean; shells
	2A	3.0-3.1	10.5	558.1	Sand, gray-brown, medium-grained; shell fragments
	2B	3.1-3.4			Clay, gray-brown, laminated, hard, compact
	3	6.5-6.8	14.0	554.6	Till clay, hard; gray and brown in swirls; angular pebbles
		7.8	15.3	553.3	Bedrock
WR-68 5.3 ft 10/8/69	1	0.0-0.3	5.3	563.3	Sand, gray-brown, fine-grained, silty
		2.3	7.6	561.0	Harder layer, probably lake clay
	2	4.0-4.3	9.3	559.3	Till clay, reddish-brown, hard, dry; angular pebbles
		5.0	10.3	558.3	Bedrock, thin gravel layer above
WR-69 35.5 ft 10/9/69	1	0.0-0.4	35.5	533.1	Mud, gray-brown, silty; snail shells
		0.5	36.0	532.1	Harder layer, probably sand
	2A	5.0-5.1	40.5	528.1	Sand, gray, medium- to fine-grained, silty
	2B	5.1-5.2			Till clay, brown, hard, compact; angular rock chips
		12.4	47.9	520.7	Bedrock
WR-70 36.8 ft 10/9/69	1	0.0-0.4	36.8	531.8	Mud, dark-gray-brown, silty
	2	3.4-5.1	40.2	528.4	Clay, gray-brown, very soft, smooth, uniform; black streaks and snail shells
	3	8.4-10.5	45.2	523.4	Clay, same as sample no. 2 with more horizontal black streaks; wood fragments at 9.3 ft penetration
	4A	13.4-14.8	50.2	518.4	Clay, same as sample no. 2
	4B	14.8-15.3			Silt, dark-brown, uniform; plant detritus
	5A	18.4-19.8	55.2	513.4	Silt, same as sample no. 4B, with laminations of plant detritus; distinct wood chips at 19.6 ft penetration

TABLE D.—*Descriptive logs of core borings*—Continued

Station number Water depth Date	Sample number	Sediment penetration (ft)	Depth (ft below water surface)	Elevation (ft above sea level)	Field description
	5B	19.8-20.0			Clay, gray, hard, compact
	6	23.4-24.0	60.2	508.4	Clay, gray-brown, very hard, compact; pods and layers of red clay; clay with angular pebbles at base; probably modified till
		55.4	92.2	476.4	Bedrock
WR-71	1	0.0-0.4	47.4	521.2	Mud, dark-gray-brown, smooth
47.4 ft	2A	7.3-8.1	54.7	513.9	Mud, dark-brown, fluid, silty; shell layer at base
10/15/69	2B	8.1-8.5			Clay, gray-brown, hard
	3	12.4-13.3	59.8	508.8	Till clay, gray-brown, stiff; red laminations and angular pebbles
		39.7	87.1	481.5	Bedrock
WR-72	1	0.0-0.4	42.8	525.8	Mud, gray-brown, smooth, soft
42.8 ft	2A	7.5-8.5	50.3	518.3	Clay, gray, smooth, soft; black streaks
10/30/69	2B	8.5-8.8			Till clay, gray, hard, compact; reddish layers and angular pebbles; sharp contact with clay above
		22.0	64.8	503.8	Harder layer, probably gravel
		23.0	66.0	502.6	Bedrock
WR-73	1	0.0-0.4	24.8	543.8	Mud, gray-brown, silty, sandy
24.8 ft	2A	5.5-6.3	30.3	538.1	Clay, gray, smooth, soft
10/30/69	2B	6.3-7.1			Clay, brown; not as soft as sample no. 2A; shell fragments and plant detritus
	3A	10.5-11.0	35.2	533.3	Plant detritus, mixed with brown silt and shells
	3B	11.0-11.3			Clay, gray, firm; black streaks
	4	15.5-16.0	40.3	528.3	Clay, gray, hard (modified till?)
		20.0	44.8	523.8	Harder layer, probably top of till clay
		35.5	60.3	508.3	Refusal in hard sticky till, probably near bedrock surface
WR-74	1A	0.0-0.3	16.4	552.2	Sand, fine- to coarse-grained; gravel; probably till lag
16.4 ft	1B	0.3-0.4			Till clay, pinkish-gray
		3.7	20.1	548.5	Harder layer, probably gravel in till
		8.7	25.1	543.5	Bedrock, thin gravel layer above
WR-75	1A	0.0-0.4	31.3	537.3	Mud, brownish-gray, silty, fluid, sandy
31.3 ft	1B	0.4-1.4			Silt, gray-brown, smooth
10/1/69	1C	1.4-1.5			Silt, gray-brown; numerous small snails and fingernail clams
	1D	1.5-3.5			Clay, gray-brown; black streaks and well-preserved fingernail clams
	2A	8.5-9.1	39.8	528.8	Silt, gray-brown, compact, sandy
	2B	9.1-9.3			Silt, gray-brown; well-preserved snails and fingernail clams
	2C	9.3-10.3			Clay, gray-brown, smooth; black streaks and swirls
	3	13.5-13.8	44.8	523.8	Clay, gray-brown, hard, compact; red, light-gray, and black mottling (modified till?)
	4	18.1-18.2	49.4	519.2	Till clay, hard, compact; igneous pebbles and chips of black shale
		28.5	59.8	508.8	Bedrock

TABLE E.—*Grain-size and volatile-solids analyses of sediment core samples*

Sample number	Water depth (ft)	Sediment penetration (ft)	Percent particle size				Percent volatile solids	Sediment type
			Gravel	Sand	Silt	Clay		
WR-2-1	30.8	surface	0.00	0.86	99.14	0.00	7.47	mud
WR-2-2	30.8	4.6-6.6	0.00	0.64	76.67	22.69	7.45	mud
WR-2-3	30.8	9.6-10.6	0.00	2.84	78.70	18.46	12.29	silt, peaty
WR-2-4	30.8	14.6-15.6	0.00	2.74	22.79	74.47	4.12	clay
WR-2-5	30.8	19.6-21.1	0.00	4.28	80.97	14.75	5.01	clay
WR-2-6	30.8	24.1-24.2	0.00	33.89	66.11	0.00	3.38	till
WR-11-1	25.1	surface	11.06	20.35	57.79	10.80	4.85	mud
WR-11-2	25.1	4.5-5.5	0.00	81.56	18.44	0.00	1.49	sand, silty
WR-11-3	25.1	9.5-10.2	0.00	9.29	70.00	20.71	4.38	silt
WR-11-4	25.1	14.5-15.0	0.00	1.57	53.34	45.09	--	clay
WR-11-5	25.1	19.5-20.0	0.00	0.88	29.83	69.29	4.20	clay
WR-11-6	25.1	24.5-25.5	0.00	0.26	34.69	65.05	5.23	clay
WR-11-7	25.1	29.5-30.5	3.27	4.27	29.65	62.81	4.13	till
WR-12-1	23.2	surface	0.00	5.51	75.85	18.64	7.09	mud
WR-12-2	23.2	1.7-2.7	0.00	4.12	65.90	29.98	5.13	mud
WR-12-3	23.2	6.7-7.7	0.00	25.68	44.24	30.08	4.94	mud, sandy
WR-12-4	23.2	11.7-12.7	0.00	46.53	53.47	0.00	3.03	silt, sandy
WR-12-5	23.2	16.7-17.7	4.51	22.56	72.93	0.00	3.86	silt, sandy
WR-12-6	23.2	21.7-22.7	0.00	19.36	66.13	14.51	--	silt, sandy
WR-12-7	23.2	26.7-27.7	5.47	28.62	61.73	4.18	3.78	till
WR-15-1	28.1	surface	0.00	3.14	96.86	0.00	7.74	mud
WR-15-2	28.1	6.6-7.6	0.00	3.47	62.03	34.50	--	silt
WR-15-3	28.1	11.6-12.5	0.00	5.73	70.05	24.22	2.73	silt
WR-15-4	28.1	16.6-17.6	0.00	1.92	29.62	68.46	4.35	clay
WR-15-5	28.1	21.6-22.6	0.00	1.36	30.52	68.12	4.86	clay
WR-15-6	28.1	26.6-27.6	0.00	2.55	40.23	57.22	4.94	till
WR-19-1	22.2	surface	3.02	93.82	3.16	0.00	2.82	sand
WR-19-2	22.2	0.2-0.4	1.48	93.12	5.40	0.00	--	sand
WR-19-3	22.2	0.4-0.5	6.92	78.82	14.26	0.00	--	sand
WR-19-4	22.2	4.0-4.7	1.69	14.53	63.72	20.06	3.93	silt
WR-19-5	22.2	4.7-5.7	0.00	8.02	69.51	22.47	7.71	silt
WR-19-6	22.2	9.0-9.2	3.85	22.75	73.40	0.00	--	till
WR-27-1	24.2	surface	0.00	3.51	41.05	55.44	8.94	mud
WR-27-2	24.2	6.6-7.3	0.64	13.59	85.77	0.00	--	silt
WR-27-3	24.2	11.6-12.6	0.00	77.14	22.86	0.00	--	sand
WR-27-4	24.2	16.1-16.5	0.00	8.03	32.80	59.17	5.20	clays
WR-28-1	25.5	0.0-0.4	--	--	--	--	6.63	mud
WR-28-2	25.5	5.0-6.1	--	--	--	--	5.48	mud, clayey
WR-28-3A	25.5	10.4-11.2	--	--	--	--	12.64	silt, peaty
WR-28-3B	25.5	11.2-12.0	--	--	--	--	11.02	silt, peaty
WR-28-4	25.5	15.3-16.4	--	--	--	--	10.74	silt, peaty
WR-28-5	25.5	20.0-20.8	--	--	--	--	3.92	clay
WR-28-6	25.5	25.5-26.6	--	--	--	--	2.46	till
WR-28-7	25.5	30.0-30.3	--	--	--	--	3.18	till
WR-33-1	31.2	surface	0.00	4.78	85.39	9.83	7.45	mud
WR-33-2	31.2	0.0-2.0	0.00	2.92	92.41	4.67	3.17	mud
WR-33-3	31.2	5.0-6.0	0.00	2.92	49.15	47.93	12.19	clay, peaty
WR-33-4	31.2	10.0-11.0	0.00	15.22	77.05	7.73	--	silt, peaty
WR-33-5	31.2	14.5-15.0	6.89	20.25	34.29	38.57	4.71	till
WR-37-1	28.1	0.0-0.4	0.80	1.60	97.60	0.00	--	mud
WR-37-2A	28.1	3.5-4.0	2.40	7.60	73.20	16.80	--	silt
WR-37-2B	28.1	4.0-4.5	5.40	14.70	45.20	34.70	--	clay, sandy
WR-37-3	28.1	7.0-7.3	1.30	24.80	73.90	0.00	--	till

TABLE E.—*Grain-size and volatile-solids analyses of sediment core samples*—Continued

Sample number	Water depth (ft)	Sediment penetration (ft)	Percent particle size				Percent volatile solids	Sediment type
			Gravel	Sand	Silt	Clay		
WR-38-1	28.2	0.0-0.4	0.00	2.00	98.00	0.00	--	mud
WR-38-2A	28.2	3.5-4.5	4.50	0.80	54.00	40.70	--	clay
WR-38-2B	28.2	4.5-5.5	0.20	1.00	55.80	43.00	--	clay
WR-38-2C	28.2	5.5-6.5	0.10	0.70	60.00	39.20	--	clay
WR-38-3	28.2	8.5-8.9	12.40	16.80	48.80	22.00	--	till
WR-39-1	27.7	0.0-0.4	0.00	1.00	99.00	0.00	--	mud
WR-39-2A	27.7	3.4-4.3	0.60	0.70	63.80	34.90	--	silt
WR-39-2B	27.7	4.3-5.1	0.50	0.80	58.30	40.40	--	silt
WR-39-2C	27.7	5.1-5.9	0.80	2.30	72.30	24.60	--	silt
WR-39-3	27.7	8.2-9.2	0.20	5.00	40.00	54.80	--	clay
WR-39-4	27.7	13.4-14.1	15.90	25.30	35.20	23.60	--	till
WR-40-1	27.9	0.0-0.4	0.00	0.70	81.80	17.50	--	mud
WR-40-2A	27.9	3.2-4.6	0.30	0.90	64.00	34.80	--	silt
WR-40-2B	27.9	4.6-5.0	9.60	19.60	54.30	16.50	--	silt, sandy
WR-40-3A	27.9	7.7-8.1	0.00	0.40	61.80	37.80	--	clay
WR-40-3B	27.9	8.1-8.7	1.30	5.50	39.50	53.70	--	till
WR-40-4	27.9	12.0-12.4	17.30	27.00	42.70	13.00	--	till
WR-48-1A	28.2	0.0-0.1	0.00	3.00	97.00	0.00	--	mud
WR-48-1B	28.2	0.1-0.4	0.00	2.20	78.40	19.40	--	mud
WR-48-2A	28.2	1.6-2.2	0.00	2.60	72.10	25.30	--	silt
WR-48-3A	28.2	2.4-2.8	0.20	1.00	77.60	21.20	--	silt
WR-48-3B	28.2	2.8-3.2	3.10	3.00	76.00	17.90	--	silt
WR-48-3C	28.2	3.2-4.5	0.10	1.10	61.60	37.20	--	clay
WR-48-3D	28.2	4.5-4.8	0.00	3.50	96.50	0.00	--	silt
WR-48-3E	28.2	4.8-5.4	0.00	1.60	59.70	38.70	--	clay
WR-48-4A	28.2	7.4-8.3	0.20	0.10	56.80	42.90	--	clay
WR-48-4B	28.2	8.3-8.6	0.80	0.40	42.00	56.80	--	clay
WR-48-5	28.2	12.1-13.4	1.90	3.70	42.20	52.20	--	till
WR-49-1	27.9	0.0-0.4	0.00	1.30	98.70	0.00	--	mud
WR-49-2A	27.9	3.2-4.0	0.00	0.40	89.70	9.90	--	silt
WR-49-2C	27.9	4.4-4.7	0.70	30.20	53.00	16.10	--	silt, sandy
WR-49-3A	27.9	7.7-8.0	0.30	1.00	61.80	36.90	--	clay
WR-49-4,5	27.9	12.7-15.7	4.30	22.40	35.80	37.50	--	till
WR-61-1	27.9	0.0-0.3	--	--	--	--	4.92	mud
WR-61-2	27.9	3.0-6.0	--	--	--	--	5.57	clay
WR-61-3	27.9	7.5-7.8	--	--	--	--	4.13	till

TABLE F.—*1967 Sediment collector data*

Collector number		Station location	Water depth (ft)	Date and time set	Date and time retrieved	Time down (days)	Height (mm)	Rate (mm/day)	Volume (ml)
Set no. 1	1-A	Starve Is. Reef	8.0	5/13/67 1810	5/24/67 0940	10.7	18.7	1.8	42.8
	2-A	Starve Is. Reef	8.0	5/13/67 1810	5/24/67 0940	10.7	18.2	1.7	41.7
	3-A	West Reef	5.0	5/13/67 0810	5/24/67 0945	11.2	10.5	0.9	24.0
	4-A	West Reef	5.0	5/13/67 0810	5/24/67 0945	11.2	11.3	1.0	25.9
	5-A	Crib Reef	5.3	5/11/67 1245	5/24/67 1250	13.0	22.0	1.7	50.4
	6-A	Crib Reef	5.3	5/11/67 1245	5/24/67 1250	13.0	17.4	1.3	39.8
	7-A	Toussaint Reef	7.5	5/11/67 1205	5/24/67 1325	13.1	28.5	2.2	65.3
	8-A	Toussaint Reef	7.5	5/11/67 1205	5/24/67 1325	13.1	29.3	2.2	67.1
Set no. 2	1-B	Starve Is. Reef	8.0	5/24/67 1000	6/2/67 1605	9.3	16.9	1.8	38.7
	2-B	Starve Is. Reef	8.0	5/24/67 1000	6/2/67 1605	9.3	15.2	1.6	34.8
	3-B	West Reef	5.0	5/24/67 1205	6/2/67 1450	9.1	6.5	0.7	14.9
	4-B	West Reef	5.0	5/24/67 1205	6/2/67 1450	9.1	6.8	0.7	15.6
	5-B	Crib Reef	5.3	5/24/67 1305	6/5/67 1245	12.0	16.9	1.4	38.7
	6-B	Crib Reef	5.3	5/24/67 1305	6/5/67 1245	12.0	9.5	0.8	21.8
	7-B	Toussaint Reef	7.5	5/24/67 1335	6/5/67 1230	12.0	27.1	2.3	62.1
	8-B	Toussaint Reef	7.5	5/24/67 1335	6/5/67 1230	12.0	26.2	2.2	60.0
Set no. 3	1-C	Starve Is. Reef	8.0	6/2/67 1610	6/26/67 1515	24.0	25.8	1.1	59.1
	2-C	Starve Is. Reef	8.0	6/2/67 1610	6/26/67 1515	24.0	22.0	0.9	50.4
	3-C	West Reef	5.0	6/2/67 1500	6/26/67 1610	24.0	13.3	0.6	30.5
	4-C	West Reef	5.0	6/2/67 1500	6/26/67 1610	24.0	14.2	0.6	32.5
	5-C	Crib Reef	5.3	6/5/67 1305	6/26/67 1710	21.2	23.4	1.1	53.6
	6-C	Crib Reef	5.3	6/5/67 1305	6/26/67 1710	21.2	20.4	1.0	46.7
	7-C	Toussaint Reef	7.5	6/5/67 1245	6/26/67 1735	21.2	28.1	1.3	64.3
	8-C	Toussaint Reef	7.5	6/5/67 1245	6/26/67 1735	21.2	25.8	1.2	59.1
Set no. 4	1-D	Starve Is. Reef	8.0	6/26/67 1530	7/10/67 1050	13.8	12.9	0.9	29.5
	2-D	Starve Is. Reef	8.0	6/26/67 1530	7/10/67 1050	13.8	12.6	0.9	28.9
	3-D	West Reef	5.0	6/26/67 1625	7/10/67 1210	13.8	6.3	0.5	14.4
	4-D	West Reef	5.0	6/26/67 1625	7/10/67 1210	13.8	9.4	0.7	21.5
	5-D	Crib Reef	5.3	6/26/67 1725	7/10/67 1315	13.8	13.2	1.0	30.2
	6-D	Crib Reef	5.3	6/26/67 1725	7/10/67 1315	13.8	11.0	0.8	25.2
	7-D	Toussaint Reef	7.5	6/26/67 1750	7/10/67 1345	13.8	15.9	1.2	36.4
	8-D	Toussaint Reef	7.5	6/26/67 1750	7/10/67 1345	13.8	17.6	1.3	40.3
Set no. 5	1-E	Starve Is. Reef	8.0	7/10/67 1055	8/22/67 0935	42.9	38.5	0.9	88.2
	2-E	Starve Is. Reef	8.0	7/10/67 1055	8/22/67 0935	42.9	49.1	1.1	112.4
	3-E	West Reef	5.0	7/10/67 1215	8/22/67 1015	42.9	26.2	0.6	60.0
	4-E	West Reef	5.0	7/10/67 1215	8/22/67 1015	42.9	23.0	0.5	52.7
	5-E	Crib Reef	5.3	7/10/67 1320	8/22/67 1100	42.9	24.3	0.6	55.6
	6-E	Crib Reef	5.3	7/10/67 1320	8/22/67 1100	42.9	19.7	0.5	45.1
	7-E	Toussaint Reef	7.5	7/10/67 1350	8/22/67 1115	42.9	45.5	1.1	104.2
	8-E	Toussaint Reef	7.5	7/10/67 1350	8/22/67 1115	42.9	42.7	1.0	97.8
1967 summary				Period of record		Total	Total	Average	Total
	1	Starve Is. Reef		5/13/67 - 8/22/67		100.6	112.6	1.1	257.9
	2	Starve Is. Reef		5/13/67 - 8/22/67		100.6	117.1	1.2	268.2
	3	West Reef		5/13/67 - 8/22/67		101.5	62.8	0.6	143.8
	4	West Reef		5/13/67 - 8/22/67		101.5	64.7	0.6	148.2
	5	Crib Reef		5/11/67 - 8/22/67		102.9	99.8	1.0	228.5
	6	Crib Reef		5/11/67 - 8/22/67		102.9	78.0	0.8	178.6
	7	Toussaint Reef		5/11/67 - 8/22/67		102.9	145.1	1.4	332.3
	8	Toussaint Reef		5/11/67 - 8/22/67		102.9	141.6	1.4	324.3
				Total average		102.0	102.7	1.0	235.2

TABLE G.—*1968 Sediment collector data*

Collector number		Station location	Water depth (ft)	Date and time set	Date and time retrieved	Time down (days)	Height (mm)	Rate (mm/day)	Volume (ml)
Set no. 1	1-A	Starve Is. Reef	8.0	4/26/68 1415	6/4/68 1015	38.8	72.5	1.9	166.0
	2-A	Starve Is. Reef	8.0	4/26/68 1415	6/4/68 1015	38.8	61.0	1.6	139.6
	3-A	West Reef	5.0	4/26/68 1305	6/5/68 1040	39.9	25.0	0.6	57.3
	4-A	West Reef	5.0	4/26/68 1305	6/5/68 1040	39.9	46.8	1.2	107.2
	5-A	Crib Reef	5.5	4/26/68 0935	6/5/68 0920	40.0	76.7	1.9	175.6
	6-A	Crib Reef	5.5	4/26/68 0935	6/5/68 0920	40.0	76.0	1.9	174.0
	7-A	Toussaint Reef	7.5	4/26/68 0830	6/5/68 0850	40.0	75.3	1.9	172.4
	8-A	Toussaint Reef	7.5	4/26/68 0830	6/5/68 0850	40.0	69.2	1.7	158.5
Set no. 2	1-B	Starve Is. Reef	8.0	6/4/68 1035	6/19/68 1800	15.4	23.7	1.5	54.2
	2-B	Starve Is. Reef	8.0	6/4/68 1035	6/19/68 1800	15.4	33.4	2.2	76.5
	3-B	West Reef	5.0	6/5/68 1055	6/19/68 1655	14.3	9.2	0.6	21.0
	4-B	West Reef	5.0	6/5/68 1055	6/19/68 1655	14.3	8.3	0.6	19.0
	5-B	Crib Reef	5.5	6/5/68 0930	6/20/68 0915	15.0	32.0	2.1	73.3
	6-B	Crib Reef	5.5	6/5/68 0930	6/20/68 0915	15.0	33.5	2.2	76.7
	7-B	Toussaint Reef	7.5	6/5/68 0905	6/20/68 0955	15.0	31.5	2.1	72.1
	8-B	Toussaint Reef	7.5	6/5/68 0905	6/20/68 0955	15.0	32.5	2.2	74.4
Set no. 3	1-C	Starve Is. Reef	8.0	6/19/68 1825	7/26/68 1330	36.8	40.2	1.1	92.1
	2-C	Starve Is. Reef	8.0	6/19/68 1825	7/26/68 1330	36.8	42.1	1.1	96.4
	3-C	West Reef	5.0	6/19/68 1710	7/22/68 1615	33.0	23.0	0.7	52.7
	4-C	West Reef	5.0	6/19/68 1710	7/22/68 1615	33.0	22.5	0.7	51.5
	5-C	Crib Reef	5.5	6/20/68 0925	7/26/68 1130	36.1	42.8	1.2	98.0
	6-C	Crib Reef	5.5	6/20/68 0925	7/26/68 1130	36.1	41.0	1.1	93.9
	7-C	Toussaint Reef	7.5	6/20/68 1005	7/26/68 1015	36.0	55.8	1.5	127.8
	8-C	Toussaint Reef	7.5	6/20/68 1005	7/26/68 1015	36.0	51.2	1.4	117.2
Set no. 4	1-D	Starve Is. Reef	8.0	7/26/68 1345	8/19/68 1700	24.1	25.4	1.1	58.2
	2-D	Starve Is. Reef	8.0	7/26/68 1345	8/19/68 1700	24.1	28.6	1.2	65.5
	3-D	West Reef	5.0	7/22/68 1640	8/8/68 1150	16.8	8.5	0.5	19.5
	4-D	West Reef	5.0	7/22/68 1640	8/8/68 1150	16.8	9.0	0.5	20.6
	5-D	Crib Reef	5.5	7/26/68 1200	8/21/68 1030	25.9	20.3	0.8	46.5
	6-D	Crib Reef	5.5	7/26/68 1200	8/21/68 1030	25.9	21.0	0.8	48.1
	7-D	Toussaint Reef	7.5	7/26/68 1035	8/21/68 1100	26.0	27.5	1.1	63.0
	8-D	Toussaint Reef	7.5	7/26/68 1035	8/21/68 1100	26.0	25.9	1.0	59.3
Set no. 5	1-E	Starve Is. Reef	8.0	8/19/68 1715	9/26/68 0930	37.7	65.8	1.7	150.7
	2-E	Starve Is. Reef	8.0	8/19/68 1715	9/26/68 0930	37.7	56.0	1.5	128.2
	3-E	West Reef	5.0	8/8/68 1210	9/26/68 1045	48.9	42.7	0.9	97.8
	4-E	West Reef	5.0	8/8/68 1210	9/26/68 1045	48.9	35.0	0.7	80.2
	5-E	Crib Reef	5.5	8/21/68 1045	9/26/68 1330	36.1	45.6	1.3	104.4
	6-E	Crib Reef	5.5	8/21/68 1045	9/26/68 1330	36.1	36.4	1.0	83.4
	7-E	Toussaint Reef	7.5	8/21/68 1115	9/26/68 1440	36.2	57.5	1.6	131.7
	8-E	Toussaint Reef	7.5	8/21/68 1115	9/26/68 1440	36.2	56.7	1.6	129.8
Set no. 6	1-F	Starve Is. Reef	8.0	9/26/68 0945	10/17/68 1330	21.1	53.4	2.5	122.3
	2-F	Starve Is. Reef	8.0	9/26/68 0945	10/17/68 1330	21.1	58.2	2.8	133.3
	3-F	West Reef	5.0	9/26/68 1100	10/18/68 1100	22.0	22.6	1.0	51.8
	4-F	West Reef	5.0	9/26/68 1100	10/18/68 1100	22.0	23.4	1.1	53.6
	5-F	Crib Reef	5.5	9/26/68 1350	10/16/68 1000	19.8	32.0	1.6	73.3
	6-F	Crib Reef	5.5	(Collector lost on station)		--	--	--	--
	7-F	Toussaint Reef	7.5	9/26/68 1430	10/16/68 1030	19.8	46.1	2.3	105.6
	8-F	Toussaint Reef	7.5	9/26/68 1430	10/16/68 1030	19.8	45.9	2.3	105.1
1968 summary				Period of record		Total	Total	Average	Total
	1	Starve Is. Reef		4/26/68 - 10/17/68		173.9	281.0	1.6	643.5
	2	Starve Is. Reef		4/26/68 - 10/17/68		173.9	279.3	1.6	639.6
	3	West Reef		4/26/68 - 10/18/68		174.9	131.0	0.7	300.0
	4	West Reef		4/26/68 - 10/18/68		174.9	145.0	0.8	332.1
	5	Crib Reef		4/26/68 - 10/16/68		172.9	249.4	1.4	571.1
	6	Crib Reef		4/26/68 - 9/26/68		153.1	207.9	1.4	476.1
	7	Toussaint Reef		4/26/68 - 10/16/68		173.0	293.7	1.7	672.6
	8	Toussaint Reef		4/26/68 - 10/16/68		173.0	281.4	1.6	644.3
				Total average		171.2	233.6	1.4	534.9

TABLE H.—*1969 Sediment collector data*

Collector number		Station location	Water depth (ft)	Date and time set		Date and time retrieved		Time down (days)	Height (mm)	Rate (mm/day)	Volume (ml)
Set no. 1	1-A	Starve Is. Reef	8.0	4/3/69	1200	4/14/69	1130	11.0	6.0	0.6	13.7
	2-A	Starve Is. Reef	8.0	4/3/69	1200	4/14/69	1130	11.0	5.0	0.5	11.5
	3-A	Kelleys Is. Shoal	7.0	4/7/69	1500	4/24/69	1445	17.0	17.0	1.0	38.9
	4-A	Kelleys Is. Shoal	7.0	4/7/69	1500	4/24/69	1445	17.0	16.0	0.9	36.6
	5-A	Gull Is. Shoal	16.0	5/15/69	1000	5/29/69	1430	14.2	8.2	0.6	18.8
	6-A	Gull Is. Shoal	16.0	5/15/69	1000	5/29/69	1430	14.2	8.0	0.6	18.3
	7-A	Gull Is. Deep #1	38.5	5/15/69	1015	5/29/69	1445	14.2	11.0	0.8	25.2
	8-A	Gull Is. Deep #1	38.5	5/15/69	1015	5/29/69	1445	14.2	11.0	0.8	25.2
Set no. 2	1-B	Starve Is. Reef	8.0	4/14/69	1140	4/25/69	1140	11.0	35.0	3.2	80.2
	2-B	Starve Is. Reef	8.0	4/14/69	1140	4/25/69	1140	11.0	37.0	3.4	84.7
	3-B	Kelleys Is. Shoal	7.0	4/24/69	1500	5/7/69	1020	12.8	3.0	0.2	6.9
	4-B	Kelleys Is. Shoal	7.0	4/24/69	1500	5/7/69	1020	12.8	3.0	0.2	6.9
	5-B	Gull Is. Shoal	16.0	5/29/69	1440	6/17/69	1700	19.1	9.2	0.5	21.1
	6-B	Gull Is. Shoal	16.0	5/29/69	1440	6/17/69	1700	19.1	10.0	0.5	22.9
	7-B	Gull Is. Deep #1	38.5	5/29/69	1500	6/17/69	1645	19.1	13.7	0.7	31.4
	8-B	Gull Is. Deep #1	38.5	5/29/69	1500	6/17/69	1645	19.1	13.7	0.7	31.4
Set no. 3	1-C	Starve Is. Reef	8.0	4/25/69	1155	5/13/69	0945	17.9	27.0	1.5	61.8
	2-C	Starve Is. Reef	8.0	4/25/69	1155	5/13/69	0945	17.9	25.0	1.4	57.3
	3-C	Kelleys Is. Shoal	7.0	5/7/69	1040	5/21/69	1050	14.0	10.5	0.8	24.0
	4-C	Kelleys Is. Shoal	7.0	5/7/69	1040	5/21/69	1050	14.0	10.3	0.7	23.6
	5-C	Gull Is. Shoal	16.0	6/17/69	1715	7/2/69	1030	14.7	9.2	0.6	21.1
	6-C	Gull Is. Shoal	16.0	6/17/69	1715	7/2/69	1030	14.7	5.1	0.4	11.7
	7-C	Gull Is. Deep #1	38.5	6/17/69	1700	7/2/69	1100	14.7	14.8	1.0	33.9
	8-C	Gull Is. Deep #1	38.5	6/17/69	1700	7/2/69	1100	14.7	14.9	1.0	34.1
Set no. 4	1-D	Starve Is. Reef	8.0	5/13/69	1000	5/29/69	1000	16.0	14.0	0.9	32.1
	2-D	Starve Is. Reef	8.0	5/13/69	1000	5/29/69	1000	16.0	14.0	0.9	32.1
	3-D	Kelleys Is. Shoal	7.0	5/21/69	1120	6/3/69	1200	14.0	6.5	0.5	14.9
	4-D	Kelleys Is. Shoal	7.0	5/21/69	1120	6/3/69	1200	14.0	4.7	0.3	10.8
	5-D	Gull Is. Shoal	16.0	7/2/69	1035	7/11/69	1345	9.1	25.0	2.8	57.3
	6-D	Gull Is. Shoal	16.0	7/2/69	1035	7/11/69	1345	9.1	25.2	2.8	57.7
	7-D	Gull Is. Deep #1	38.5	7/2/69	1115	7/11/69	1330	9.1	41.5	4.6	95.0
	8-D	Gull Is. Deep #1	38.5	7/2/69	1115	7/11/69	1330	9.1	44.8	4.9	102.6
Set no. 5	1-E	Starve Is. Reef	8.0	5/29/69	1015	6/27/69	0900	29.0	29.0	1.0	66.4
	2-E	Starve Is. Reef	8.0	5/29/69	1015	6/27/69	0900	29.0	26.5	0.9	60.7
	3-E	Kelleys Is. Shoal	7.0	6/3/69	1220	6/17/69	1200	14.0	7.7	0.6	17.6
	4-E	Kelleys Is. Shoal	7.0	6/3/69	1220	6/17/69	1200	14.0	5.4	0.4	12.4
	5-E	Gull Is. Shoal	16.0	7/11/69	1350	7/30/69	1415	19.0	4.2	0.2	9.6
	6-E	Gull Is. Shoal	16.0	7/11/69	1350	7/30/69	1415	19.0	4.7	0.3	10.8
	7-E	Gull Is. Deep #2	39.5	7/11/69	1400	7/30/69	1345	19.0	9.7	0.5	22.2
	8-E	Gull Is. Deep #2	39.5	7/11/69	1400	7/30/69	1345	19.0	8.2	0.4	18.8
Set no. 6	3-F	Kelleys Is. Shoal	7.0	6/17/69	1210	7/11/69	1300	24.0	17.0	0.7	38.9
	4-F	Kelleys Is. Shoal	7.0	6/17/69	1210	7/11/69	1300	24.0	18.2	0.8	41.7
	5-F	Gull Is. Shoal	16.0	7/30/69	1420	8/15/69	1040	15.8	3.6	0.2	8.2
	6-F	Gull Is. Shoal	16.0	7/30/69	1420	8/15/69	1040	15.8	4.8	0.3	10.9
	7-F	Gull Is. Deep #2	39.5	7/30/69	1350	8/15/69	1015	15.8	8.5	0.5	19.5
	8-F	Gull Is. Deep #2	39.5	7/30/69	1350	8/15/69	1015	15.8	7.1	0.5	16.3
Set no. 7	3-G	Kelleys Is. Shoal	7.0	7/11/69	1315	7/30/69	1315	19.0	4.2	0.2	9.6
	4-G	Kelleys Is. Shoal	7.0	7/11/69	1315	7/30/69	1315	19.0	5.0	0.3	11.5
	5-G	Gull Is. Shoal	16.0	8/15/69	1045	9/11/69	1300	27.1	22.0	0.8	50.4
	6-G	Gull Is. Shoal	16.0	8/15/69	1045	9/11/69	1300	27.1	22.5	0.8	51.5
	7-G	Gull Is. Deep #2	39.5	8/15/69	1020	9/11/69	1130	27.1	33.2	1.2	76.0
	8-G	Gull Is. Deep #2	39.5	8/15/69	1020	9/11/69	1130	27.1	35.2	1.3	80.6

TABLE H.—*1969 Sediment collector data*—Continued

Collector number		Station location	Water depth (ft)	Date and time set	Date and time retrieved	Time down (days)	Height (mm)	Rate (mm/day)	Volume (ml)
Set no. 8	3-H	Kelleys Is. Shoal	7.0	7/30/69 1325	8/15/69 0930	15.8	4.0	0.3	9.2
	4-H	Kelleys Is. Shoal	7.0	7/30/69 1325	8/15/69 0930	15.8	3.0	0.2	6.9
	5-H	Gull Is. Shoal	16.0	9/11/69 1305	9/29/69 1145	17.9	28.0	1.6	64.1
	6-H	Gull Is. Shoal	16.0	9/11/69 1305	9/29/69 1145	17.9	37.7	2.1	86.3
	7-H	Gull Is. Deep #2	39.5	9/11/69 1135	9/29/69 1100	18.0	38.7	2.2	88.6
	8-H	Gull Is. Deep #2	39.5	9/11/69 1135	9/29/69 1100	18.0	41.0	2.3	93.9
Set no. 9	3-I	Kelleys Is. Shoal	7.0	8/15/69 0945	9/11/69 1100	27.1	15.0	0.6	34.4
	4-I	Kelleys Is. Shoal	7.0	8/15/69 0945	9/11/69 1100	27.1	15.0	0.6	34.4
	5-I	Gull Is. Shoal	16.0	9/29/69 1200	10/28/69 1030	28.9	46.5	1.6	106.5
	6-I	Gull Is. Shoal	16.0	9/29/69 1200	10/28/69 1030	28.9	47.3	1.6	108.3
	7-I	Gull Is. Deep #2	39.5	9/29/69 1115	10/28/69 1100	29.0	57.8	2.0	132.4
	8-I	Gull Is. Deep #2	39.5	9/29/69 1115	10/28/69 1100	29.0	60.0	2.1	137.4
Set no. 10	3-J	Kelleys Is. Shoal	7.0	9/11/69 1115	9/29/69 1030	18.0	20.2	1.1	46.3
	4-J	Kelleys Is. Shoal	7.0	9/11/69 1115	9/29/69 1030	18.0	20.2	1.1	46.3
1969 summary				Period of record		Total	Total	Average	Total
	1	Starve Is. Reef		4/3/69 - 6/27/69		84.9	111.0	1.3	254.2
	2	Starve Is. Reef		4/3/69 - 6/27/69		84.9	107.5	1.3	246.3
	3	Kelleys Is. Shoal		4/7/69 - 9/29/69		174.7	105.1	0.6	240.7
	4	Kelleys Is. Shoal		4/7/69 - 9/29/69		174.7	100.8	0.6	231.1
	5	Gull Is. Shoal		5/15/59 - 10/28/69		165.8	155.9	0.9	357.1
	6	Gull Is. Shoal		5/15/69 - 10/28/69		165.8	165.3	1.0	378.3
	7	Gull Is. Deep #1		5/15/69 - 7/11/69		57.1	81.0	1.4	170.6
	8	Gull Is. Deep #1		5/15/69 - 7/11/69		57.1	84.4	1.5	178.4
	7	Gull Is. Deep #2		7/11/69 - 10/28/69		108.9	147.9	1.4	338.7
	8	Gull Is. Deep #2		7/11/69 - 10/28/69		108.9	151.5	1.4	347.0
				Total average		118.3	121.0	1.1	274.2

TABLE I.—*Grain-size analyses of sediment collector samples*

	Collector number	Particle distribution (percent) in relation to particle diameters (mm)													
		Sand	Silt							Clay				Summary		
		>.061	.061 to .045	.045 to .032	.032 to .020	.020 to .015	.015 to .009	.009 to .006	.006 to .004	<.004	.004 to .003	.003 to .002	<.002	Sand	Silt	Clay
1967 data	2-A 2-B 2-C	11.22	0.00	6.34	49.28	21.46	7.80	3.90						11.22	88.78	0.00
	2-D 2-E	1.38	0.00	12.39	37.15	0.46	5.96	12.84	11.93		1.83	0.92	15.14	1.38	80.73	17.89
	4-A 4-B 4-C	4.05	0.00	37.84	45.95	1.35	10.81							4.05	95.95	0.00
	4-D 4-E	3.39	2.54	31.36	44.07	2.54	6.78	2.54	6.78					3.39	96.61	0.00
	6-A 6-B 6-C	1.96	1.31	29.41	51.63	0.00	6.54	3.92	5.23					1.96	98.04	0.00
	6-D 6-E	2.94	8.82	30.89	22.06	0.00	23.53	11.76						2.94	97.06	0.00
	7-A 7-B 7-C	3.03	0.00	0.00	51.08	33.77	6.06	2.60	3.46					3.03	96.97	0.00
	7-D 7-E	2.06	2.58	1.03	63.40	8.25	7.22	1.55	1.55		5.15	3.09	4.12	2.06	85.58	12.36
1968 data	1-A	1.85	12.96	12.04	22.22	15.75	12.96	13.89	8.33					1.85	98.15	0.00
	3-A	2.17	6.52	70.66	20.65									2.17	97.83	0.00
	5-A	4.88	7.31	50.00	11.59	1.21	11.59	3.05	2.44		7.93			4.88	87.19	7.93
	7-A	5.20	8.44	56.49	8.44	3.25	18.18							5.20	94.80	0.00
	1-B	2.25	14.61	61.80	8.99	12.35								2.25	97.75	0.00
	3,4-B	0.00	28.21	20.51	51.28									0.00	100.00	0.00
	5,6-B	1.32	5.27	64.47	3.29	1.97	7.89	7.24	8.55					1.32	98.68	0.00
	7,8-B	1.59	4.76	40.21	37.57	5.82	3.17	6.88						1.59	98.41	0.00
	1-C	0.81	7.25	75.81	2.42	2.42	11.29							0.81	99.19	0.00
	3-C	2.08	6.25	62.50	29.17									2.08	97.92	0.00
	5-C	2.25	3.37	42.70	7.87	6.74	1.12	5.62	7.86		4.49	2.25	15.73	2.25	75.28	22.47
	7-C	1.28	3.85	24.36	20.52	14.10	14.10	21.79						1.28	98.72	0.00
	1-D	1.59	7.94	73.01	17.46									1.59	98.41	0.00
	3,4-D	3.45	3.45	55.17	37.93									3.45	96.55	0.00
	5-D	2.27	29.55	36.36	31.82									2.27	97.73	0.00
	7-D	2.22	6.67	60.00	6.67	4.44	20.00							2.22	97.78	0.00
	1-E	0.00	5.43	64.13	16.30	4.35	9.79							0.00	100.00	0.00
	3-E	1.79	7.14	14.29	37.50	19.64	19.64							1.79	98.21	0.00
	5-E	5.45	10.91	58.18	1.82	3.64	20.00							5.45	94.55	0.00
	7-E	3.33	11.67	63.33	21.67									3.33	96.67	0.00
	1-F	0.93	7.41	49.07	29.63	2.78	10.18							0.93	99.07	0.00
	3-F	1.79	19.64	62.50	16.07									1.79	98.21	0.00
	5-F	1.79	0.00	44.64	10.71	3.57	39.29							1.79	98.21	0.00
	7-F	2.22	13.33	36.67	4.44	6.67	10.00	2.23	3.33		0.00	3.33	17.78	2.22	76.67	21.11

TABLE I.—*Grain-size analyses of sediment collector samples*—Continued

	Collector number	Particle distribution (percent) in relation to particle diameters (mm)													
		Sand	Silt							Clay				Summary	
		>.061	.061 to .045	.045 to .032	.032 to .020	.020 to .015	.015 to .009	.009 to .006	.006 to .004	<.004	.004 to .003	.003 to .002	<.002	Sand	Silt	Clay
1969 data	3,4-B		27.27	72.73											100.00	
	3,4-C	2.38	33.33	42.86	2.38	19.05								2.38	97.62	
	3,4-D, E		7.41	70.37	22.22										100.00	
	3,4-F	2.32	12.79	77.91	6.98									2.32	97.68	
	3,4-G, H		30.77	69.23											100.00	
	3,4-I	4.35	1.45	14.49	60.87	18.84								4.35	95.65	
	3,4-J	2.44	4.06	31.71	55.29	6.50								2.44	97.56	
	5,6-A, B	11.76	38.24	35.30	14.70									11.76	88.24	
	5,6-C		51.85	37.04	11.11										100.00	
	5,6-D	3.52	8.45	49.31	19.72		3.52	5.63	5.63	4.22				3.52	92.26	4.22
	5,6-E, F	5.56	16.67	16.67	16.67	44.43								5.56	94.44	
	5,6-G	3.16	11.58	73.69	2.10	7.37	2.10							3.16	96.84	
	5,6-H	2.63	5.26	25.79	46.32	4.21	3.16	2.10	6.32	4.21				2.63	93.16	4.21
	5,6-I	3.32	1.02	2.30	27.89	30.70	13.04	3.07	6.90	11.76				3.32	84.92	11.76
	7,8-A	5.71	68.58	25.71										5.71	94.29	
	7,8-B	2.94	13.24	70.59	4.41	1.47	7.35							2.94	97.06	
	7,8-C, D	2.00	5.50	25.50	38.00	4.50	9.50	5.50	2.50	7.00				2.00	91.00	7.00
	7,8-E, F	1.78	35.71	39.28	3.58		16.07	3.58						1.78	98.22	
	7,8-G	1.44	0.48	1.44	54.81	23.56	11.54	2.40	0.48	3.85				1.44	94.71	3.85
	7,8-H	1.53	3.82	12.60	54.97	0.76	5.72	5.72	5.34	9.54				1.53	88.93	9.54
	7,8-I	1.89	2.32	3.59	14.10	36.84	22.95	1.68	5.05	11.58				1.89	86.53	11.58

TABLE J.—

Station number	Average current direction and velocity (tenths of knots)															
	North				Northeast				East				Southeast			
	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30
1 Surface													NE 1			
Bottom													N 1			
2 Surface													NE 3			
Bottom													SW 1			
3 Surface						SW 3				SW 3				NW 1		
Bottom						E 1				E 1				SE 1		
4 Surface		S 3				S 3	S 3	SW 3			SW 1	SW 3			NW 1	
Bottom		SE 1				SE 1	SE 3	E 3			SE 1	E 3			S 1	
5 Surface		S 3				E 3			NE 1							
Bottom		E 3				E 3			NE 1							
6 Surface		S 3				SW 3	SW 3			1	SW 3	SW 3		NE 1		
Bottom		E 1				NE 1	E 3			S 1	SE 1	E 1		SE 1		
7 Surface	SW 5									N 1						
Bottom	SW 1	SW 1	SW 1		SW 1	SW 1	W 1			NE 1	W 1		NW 1			
8 Surface	SW 1	S 1	S 1		SW 1	SW 3	S 1	W 3		W 1	W 3		W 1	W 1		
Bottom								N 1		W 1	NW 3			W 1		
9 Surface									SE 1							
Bottom									E 1							
10 Surface																
Bottom																
11 Surface									S 3							
Bottom									N 1							
12 Surface						NW 3										
Bottom						NE 1										
13 Surface						W 3										
Bottom						NE 1										
14 Surface						SW 3										
Bottom						NE 1										
15 Surface						W 3	W 3			NW 3	NW 5			NW 3	NW 5	
Bottom						W 3	W 3			NW 3	N 3			N 3	N 3	
16 Surface					W 1	SW 3				NW 3			S 1			
Bottom					S 1	SE 3				NW 3			N 1			
17 Surface										SW 3						
Bottom										NE 3						
18 Surface						W 3				W 3			N 3			
Bottom						NE 3				NE 3			N 1			
19 Surface		SW 3				SW 3										
Bottom		E 3				E 3										
20 Surface						W 5							N 3			
Bottom						NE 1							N 15			
21 Surface										W 3						
Bottom										NE 1						
22 Surface	SW 1				SW 1	SW 3				NW 5						
Bottom	NW 1				N 1	N 3				SE 1						
23 Surface										NW 3						
Bottom										NW 1						
24 Surface										NW 5				NW 5		
Bottom										E 1				E 1		
25 Surface					SW 3	NW 1			W 1	N 3	N 1		NW 3	N 3		
Bottom					W 3	SE 1			NE 1	SE 1			NE 1	SE 1	NW 1	
26 Surface					W 1				SW 3							
Bottom						SE 1				SE 1						
27 Surface		SE 1				S 3	SW 1			N 3			E 3			
Bottom		E 1				NE 1	SE 1			E 1			SW 1			
28 Surface	SE 3	E 5				E 5				E 5						
Bottom	SE 3	E 5				E 5				E 5						
29 Surface													NE 1			
Bottom													SE 1			
30 Surface																
Bottom																

Current measurements

in relation to wind direction and velocity (mph)

South				Southwest				West				Northwest			
0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30
NE 1 N 1		NE 7 SW 1		SW 1	NE 1 NE 1	NE 7 SW 1									
SW 7	NE 3			SW 7	NE 3 NW 1										
E 3 E 1	E 3 E 3			SE 3 E 1	NE 3 NE 3				E 5 NE 1				SE 3 SE 1		
E 3 W 1	1 S 1			E 3 W 1	NE 1 S 1				E 3 S 1						
NE 3 SW 1	NE 1 NE 1			E 1 W 1	NE 1 W 1	NE 3 S 1		SE 3 W 1	SE 3 NW 1			E 3 S 1	SE 3 N 1	SW 3 W 1	
E 3 SW 5	NE 1 SE 1	NE 3 NE 3		E 3 SW 5	E 3 N 1	SE 5 NE 3		SE 1 NE 1							
N 1				N 1	E 1 E 1			SW 1 N 1	E 1 E 1			E 1 NE 1	E 3 NE 3	E 3 NW 1	
N 1	N 1			NE 1	E 1 NE 1			SE 1 NW 1	E 1 NE 1				SE 3 SE 3	S 3	
					NW 1	N 1	NE 3 S 3	NE 1 S 1	NW 1	N 1					
				NE 3	E 3 N 1			NE 3	E 3 N 1						
					E 1 N 1				E 1 N 1						
					E 1 NE 1				E 1 NE 1						
N 5 NW 1				N 5 NW 1	E 1			N 1	E 1						
					E 3 NW 1				E 3 NW 1						
E 3 E 1	E 3 E 3			E 3 NE 1	E 3 E 1		E 5	N 5	E 3 E 3		E 5				
				NE 3 N 1	NE 1 NW 1	E 3 SE 1		SE 1 S 1		E 3 SE 1		SE 3 SE 1	SE 3 NE 1		
								SE 3 SW 1							
N 3 N 1						SE 3 SW 1				SE 3 SW 1					
						NE 3 SW 1				S 3 SW 1					
N 3 NW 1				NE 3	E 3	SE 1 N 1				SE 1 N 1					
				SW 1		NE 3 NE 1	E 3	SW 1		E 1 SW 1	E 3				
					W 3 W 1	W 1 S 1		S 1	E 3	SE 1 SW 3		S 1 E 1	SE 3 SE 3		
NE 3 W 3				NE 3 W 3	W 1 SE 1	SE 1 NE 1				SE 1 NE 1					
N 5 N 3				N 5 N 3		E 3 E 1		W 1 SW 1	W 1 SW 1	E 3 E 1					
N 3 E 1	N 1 NW 1	N 1 NW 1			N 1	E 3 S 1	N 1 NE 1	E 3 NE 1	SE 3 E 1	E 3 S 1		E 3 N 1	SE 3 E 1		
E 3 W 1	E 3 NW 3			NE 1 S 1	E 3 NW 1			E 3 NE 1	SE 3 NW 1						
N 3 NE 1				NW 1 NW 1	NE 1 NW 1			E 3 N 3				SE 3 E 3			
	E 5 W 3				E 5 W 3										
					SE 1 W 1										

TABLE J.—*Current*

Station number	Average current direction and velocity (tenths of knots)															
	North				Northeast				East				Southeast			
	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30
31 Surface																
Bottom																
32 Surface																
Bottom																
33 Surface			W 1													
Bottom			NW 1													
34 Surface																
Bottom																
35 Surface									SE 1	SE 1						
Bottom									SE 1	SE 1						
36 Surface					E 3				E 3					N 1		
Bottom					E 1				SE 1				E 3	N 1		
37 Surface		SW 5				SW 5			NW 1	E 1			NW 1			
Bottom		W 1				W 1	SE 3	W 5		SW 1	NW 3	W 5		NW 1	NW 5	
38 Surface		S 3														
Bottom		SE 1														
39 Surface	SW 1				W 1				N 1							
Bottom	NW 1				NW 1				E 1							
40 Surface		S 3														
Bottom		S 3														
41 Surface		E 3					E 7									
Bottom		E 3					S 5									
42 Surface																
Bottom																
43 Surface						SW 5										
Bottom						SW 3										
44 Surface						W 7										
Bottom						SW 3										
45 Surface																
Bottom																
46 Surface																
Bottom																
47 Surface		N 3				NE 1				NE 1			N 3			
Bottom		NE 1				NE 1			W 1	NE 1			NW 3			
48 Surface																
Bottom																
49 Surface																
Bottom																
50 Surface		S 3				S 3	SW 3									
Bottom						SE 3	SE 3									
51 Surface		N 3	SW 3			N 1	SW 5									
Bottom		SE 1	SW 3			SE 1	S 3									
52 Surface						S 1	SW 7	N 7		N 3	SW 7	N 7				
Bottom						W 1				NE 1	SW 5	N 5				
53 Surface		S 3			S 3	S 3	S 3	SW 3		N 3	SW 5	SW 3			SE 5	
Bottom		SE 1			S 1	S 1	SW 3	S 3		SE 3	S 3	S 3			NE 3	
54 Surface											W 3					
Bottom											E 1					
55 Surface																
Bottom																
56 Surface																
Bottom																
57 Surface																
Bottom																
58 Surface	NE 1	NE 1	NE 1		S 3	SW 3			S 3	SW 3						
Bottom	NE 1	W 1	W 1		SE 1	SE 1			SE 1	SE 1						
59 Surface						S 5										
Bottom						SE 1										
60 Surface					W 5	SW 5			W 5							
Bottom					SE 1	N 1			SE 1							

measurements—Continued

in relation to wind direction and velocity (mph)

South				Southwest				West				Northwest			
0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30
NE 1	1			NE 1	1										
								S 1 NW 1							
														NW 1 W 1	
NE 3 N 1				NE 3 N 1											
				N 1 NW 1	NW 1 N 1	W 3 N 1		NE 1 N 1	NW 1 N 1	W 3 N 1		SE 1 SE 1	SE 1		
E 1	NW 1 W 1	E 3	SE 7 NE 7	NW 3 W 1	N 1 W 1	E 3 E 1	SE 7 SE 3								
		SE 3		E 5		SE 5									
					SE 1			SW 1 SW 1	SE 3 SE 1	SE 3		S 1 S 1	E 1 SE 1	SE 3	
				E 1 E 1		SW 3 W 1		E 1 E 1	E 5	S 3 W 1	SE 5 E 1	E 1	E 1 E 1	E 1	SE 3 W 3
	NE 3 NW 1				N 3 NW 1				NE 3 NW 3			S 3 S 1	SE 3 W 3		
	E 3 N 3				E 3 N 1								E 3 E 1		
					NE 5 NE 3										
	E 3 SE 1				E 3 SE 1										
	NW 1	N 1	NW 3 NW 3		SE 3 W 3	W 3 N 1	N 3 NW 3		E 5 W 3					W 3 NW 3	
		E 5 N 1			NW 5 N 3	NE 7 NE 3		NE 7 E 5	NE 7 SE 5	E 5 E 3		N 3 NE 3	N 5 NE 5		
N 3 N 3	N 3 W 3	NE 5 NW 1	N 5		NE 3 W 3	NE 5 W 3			NE 3 SW 3	NE 5 W 3			N 3 NE 1		
										NW 3 NW 5				NW 3 NW 5	
	SE 3 NW 1									W 3 NW 5				W 3 NW 5	
	E 3 N 3	NE 3 NW 3			NE 3 NW 1	NE 3 NE 3	N 3 N 3		W 1	SE 3 SW 1			S 3 W 1		
													SE 3 NE 1		
													S 3 S 1	S 3 S 1	
	E 3 W 1				E 3 NE 3	NE 3 N 5									
					S 5 SW 3				N 1 NW 1	NW 3 NW 1			N 1 NW 1	NW 3 NW 1	
					SW 3 NW 3										
					SE 3 SW 1								NE 1 W 1	NE 1 W 1	
													SE 3 SE 1		
	N 3 S 1	E 5 SW 1			N 3 S 1	E 5 SW 1									

TABLE J.—*Current*

Station number	Average current direction and velocity (tenths of knots)															
	North				Northeast				East				Southeast			
	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30
61 Surface																
Bottom																
62 Surface																
Bottom																
63 Surface										SW 1						
Bottom										W 1						
64 Surface																
Bottom									E 1							
65 Surface																
Bottom																
66 Surface																
Bottom																
67 Surface	S 1															
Bottom	SE 1															
68 Surface																
Bottom										SE 3						

measurements—Continued

in relation to wind direction and velocity (mph)																
South				Southwest				West				Northwest				
0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	0-7.5	7.5-15	15-22.5	22.5-30	
				SE 5 E 3				NE 9								
				NE 1 N 1												
				NE 1 NE 1												
								N 1 N 1								

TABLE K.—*Current velocities*

Station number	Average current velocity (knots) in relation to depth (ft)											
	Surface	5	10	15	20	25	30	35	40	45	50	60
1	0.27	0.20	0.12	0.11	0.06							
2	0.24	0.13	0.14	0.10	0.10	0.25						
3	0.25	0.22	0.17	0.15	0.12	0.11	0.11	0.12	0.12			
4	0.20	0.18	0.15	0.14	0.13	0.14	0.15					
5	0.23	0.22	0.22	0.21	0.21	0.20	0.20	0.19	0.15	0.24	0.22	
6	0.22	0.17	0.15	0.15	0.16	0.19	0.19					
7	0.23	0.23	0.23	0.18	0.17	0.16	0.03					
8	0.16	0.14	0.08									
9	0.19	0.17	0.15	0.12	0.13	0.11	0.12	0.13				
10	0.31	0.16	0.17	0.13	0.12	0.15	0.12					
11	0.26	0.21	0.12	0.11	0.13	0.12	0.08					
12	0.19	0.15	0.08	0.09	0.10	0.08	0.08					
13	0.28	0.16	0.14	0.11	0.10	0.09	0.15					
14	0.25	0.21	0.15	0.10	0.11	0.12						
15	0.37	0.29	0.36									
16	0.17	0.12	0.12	0.11								
17	0.25	0.21	0.20	0.16	0.16	0.25						
18	0.29	0.17	0.19	0.16	0.17							
19	0.24	0.12	0.09	0.09								
20	0.25	0.16	0.17	0.14								
21	0.21	0.11	0.12	0.15								
22	0.19	0.16	0.13	0.13								
23	0.17	0.14										
24	0.26	0.18	0.15	0.16								
25	0.21	0.15	0.14	0.14	0.14	0.18						
26	0.17	0.14	0.08	0.10	0.13	0.07	0.10					
27	0.21	0.17	0.11	0.11	0.10	0.11	0.15					
28	0.27	0.24	0.14	0.12	0.10	0.11						
29	0.20	0.28	0.23	0.17	0.27	0.27	0.09					
30	0.09		0.04		0.02							
31	0.07			0.15			0.60					
32	0.55			0.06		0.08						
33	0.08	0.13	0.12		0.12							
34	0.21				0.03							
35	0.10		0.02									
36	0.64	0.22	0.20	0.09		0.14						
37	0.55	0.34	0.30	0.31	0.27	0.23						
38		0.17	0.10									
39	0.19		0.13		0.11				0.08			
40	0.30	0.24	0.17									
41	0.35	0.22	0.19									
42	0.39	0.27	0.23									
43	0.37	0.25	0.24									
44	0.65	0.29	0.43		0.39							
45	0.27	0.15	0.16	0.14	0.17	0.18	0.20					
46	0.38	0.31	0.31	0.32	0.29	0.23						
47	0.35	0.30	0.28	0.27	0.27	0.26	0.15					
48	0.31	0.29	0.28	0.31	0.25	0.28	0.33					
49	0.34	0.21	0.23	0.19	0.20	0.16	0.12	0.09	0.11			
50	0.30	0.22	0.20	0.17								
51	0.22	0.14	0.13	0.09	0.19	0.14						
52	0.48	0.46	0.39	0.38	0.33							
53	0.34	0.24	0.18	0.18	0.21	0.27						
54	0.29	0.19	0.15	0.12	0.13	0.17						
55	0.25	0.21	0.22	0.19	0.19	0.20	0.09	0.09				
56	0.36	0.28	0.25	0.24	0.19	0.20	0.18	0.17	0.18	0.15		
57	0.33	0.21	0.18	0.18	0.18	0.15	0.18					
58	0.22	0.18	0.12	0.15	0.17	0.10	0.13					
59	0.37	0.28	0.21	0.16	0.15	0.14						
60	0.36	0.23	0.16	0.15	0.14	0.17	0.13					
61	0.48	0.41										
62	0.16		0.04									
63			0.04				0.01					0.09
64					0.04							
65			0.03		0.14							
66		0.11	0.15	0.21		0.01						
67			0.03		0.03							
68					0.08							
Average	0.28	0.21	0.17	0.16	0.16	0.16	0.15	0.13	0.13	0.20	0.22	0.09

WEST SISTER ISLAND
WEST SISTER REEF
CRANE REEF
BIG PICKEREL REEF
CONE REEF
LITTLE PICKEREL REEF
NIAGARA REEF
FLAT ROCK REEF
TURTLE REEF
LOCUST POINT REEF
CRIB REEF
TOUSSAINT REEF
ROUND REEF
Turtle Creek
LOCUST POINT
Toussaint River
Rushaw Creek
CAMP PERRY
Lacarpe Creek
Portage River
PORT CLINTON
ENNIS REEF
NORTHWEST REEF
WEST REEF
NORTH BASS ISLAND
SUGAR REEF
SUGAR ISLAND
RATTLESNAKE ISLAND
MIDDLE BASS ISLAND
BALLAST ISLAND
BALLAST REEF
BUCKEYE REEF
GIBRALTAR ISLAND
PUT-IN-BAY
GREEN ISLAND
SOUTH BASS ISLAND
STARVE ISLAND
STARVE ISLAND DEEP
STARVE ISLAND REEF
MOUSE ISLAND REEF
SCOTT POINT SHOAL
MOUSE ISLAND
SCOTT POINT
SOUTH SHOAL
CARPENTER POINT REEF
AMERICAN EAGLE SHOAL
CLINTON REEF
CATAWBA ISLAND
ROCK LEDGE
West Harbor
Middle Harbor
East Harbor
WEST HARBOR REEF
MIDDLE HARBOR REEF
LAKESIDE REEF
LAKESIDE
MARBLEHEAD
MARBLEHEAD PENINSULA
MARBLEHEAD REEF
BAY POINT
JOHNSON ISLAND
CEDAR POINT
SANDUSKY
PELEE ISLAND
PELEE POINT
PELEE PASSAGE
MIDDLE ISLAND
BOUNDARY
GULL ISLAND SHOAL
MIDDLE PASSAGE REEF
KELLEYS ISLAND SHOAL
KELLEYS ISLAND
AIRPORT REEF
INTERNATIONAL
SOUTH MIDDLE PASSAGE
SANDUSKY BAY

41°45′
41°40′
41°35′
41°30′
83°05′
83°00′
82°55′
82°50′
82°45′
82°40′

DEPTH CONTOURS IN FEET BELOW LOW WATER DATUM
+ LEAST DEPTH OVER REEF
CONTOUR INTERVAL 6 FEET

FEET
0 10,000 20,000 30,000
MILES
0 1/2 1 2 3 4 5 6 7 8

PLATE 1. BATHYMETRIC MAP OF THE REEF AREA OF WESTERN LAKE ERIE

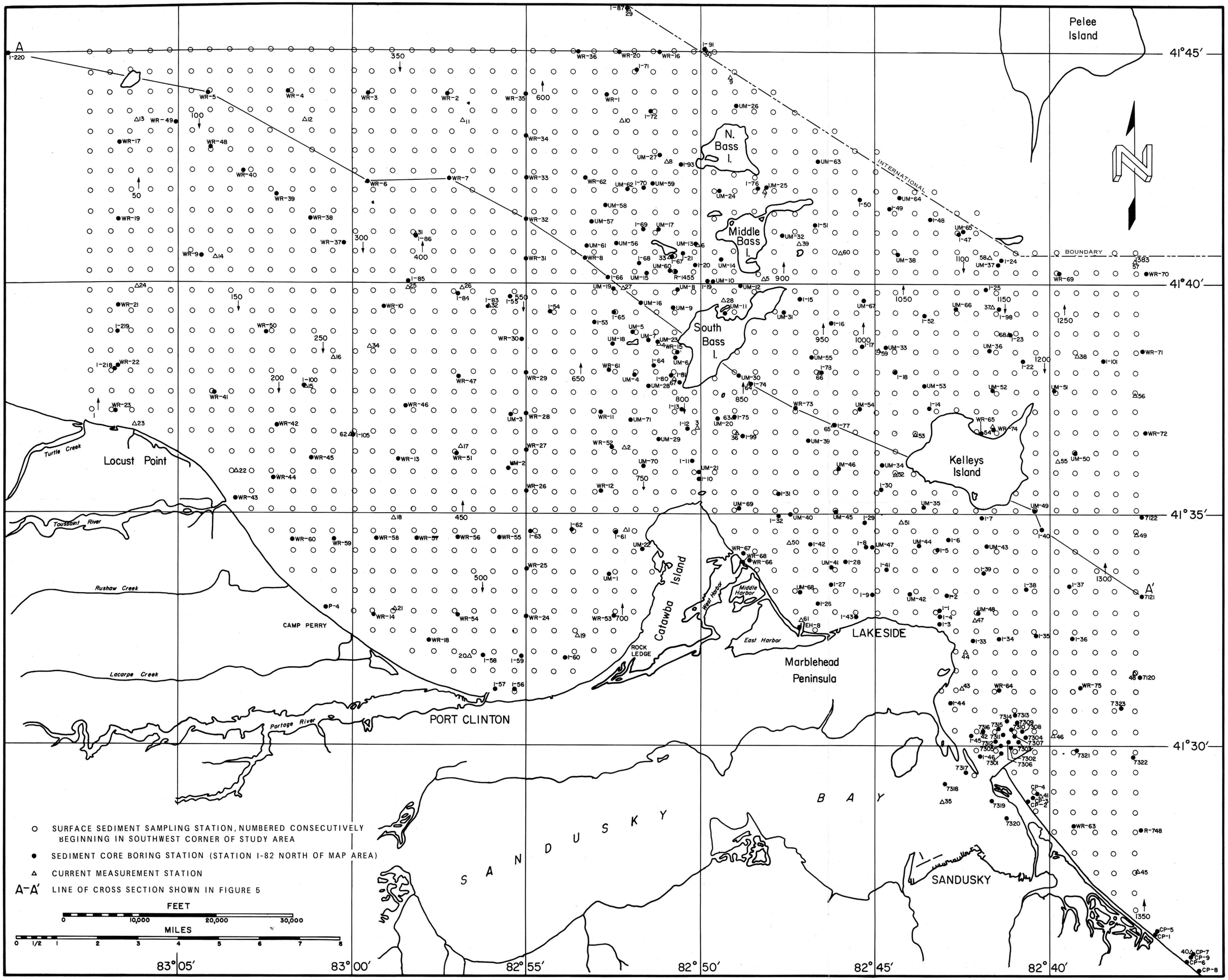
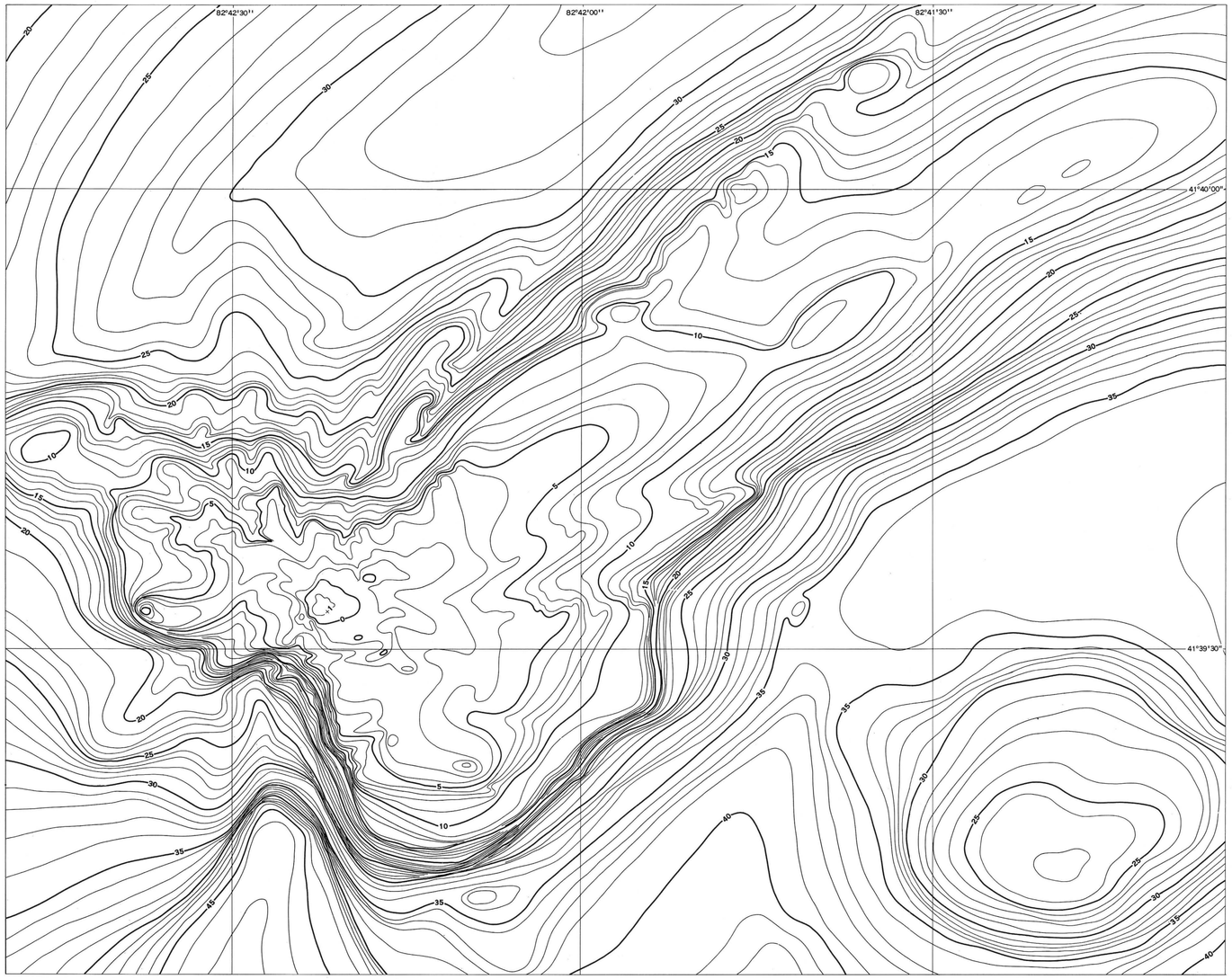
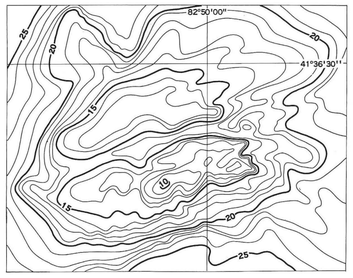


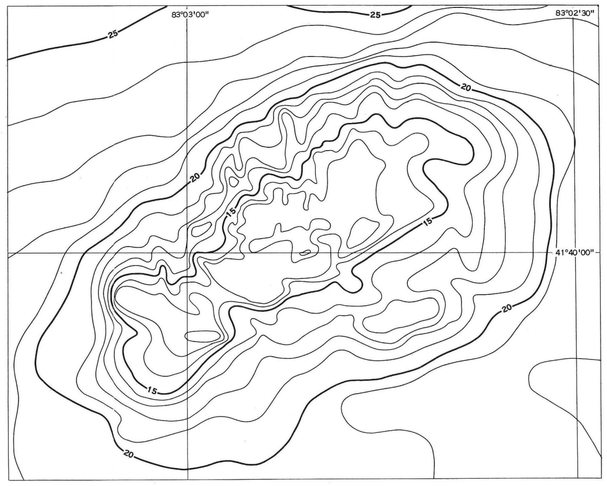
PLATE 2. SURFACE SEDIMENT SAMPLING STATIONS, SEDIMENT CORE BORING STATIONS, AND CURRENT MEASUREMENT STATIONS IN THE REEF AREA OF WESTERN LAKE ERIE



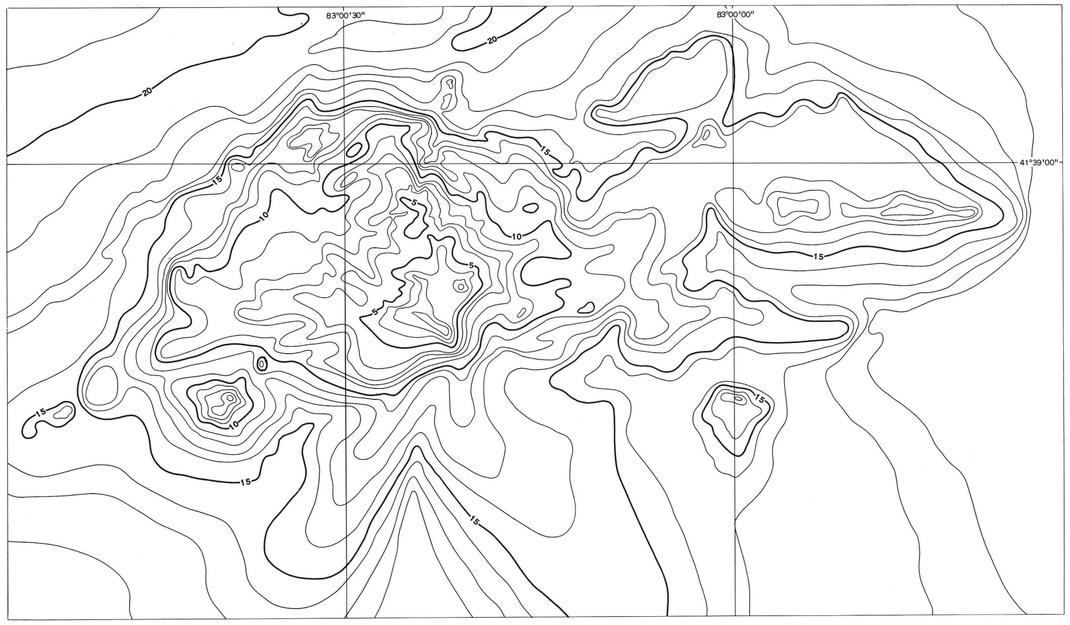
GULL ISLAND SHOAL



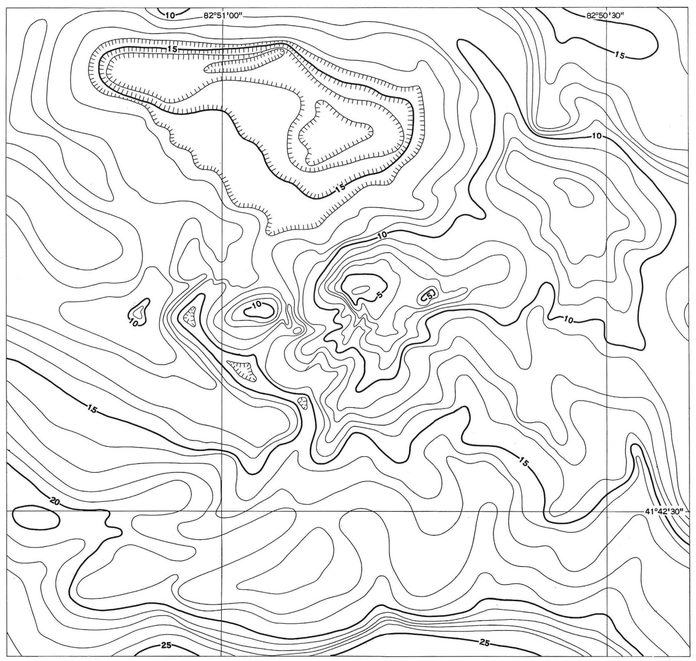
MOUSE ISLAND REEF



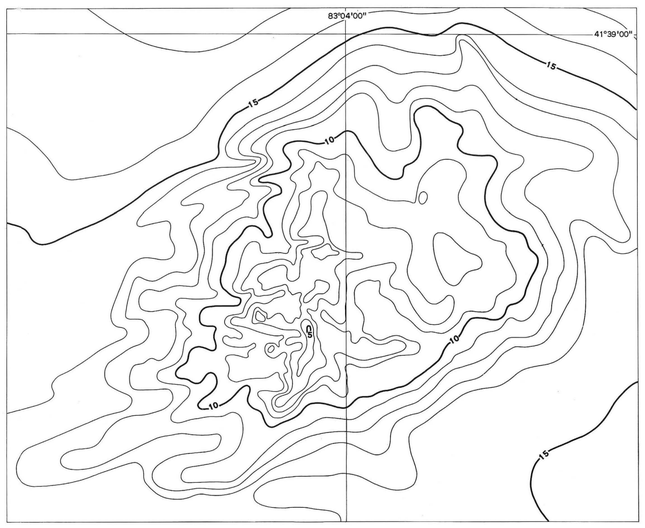
CONE REEF



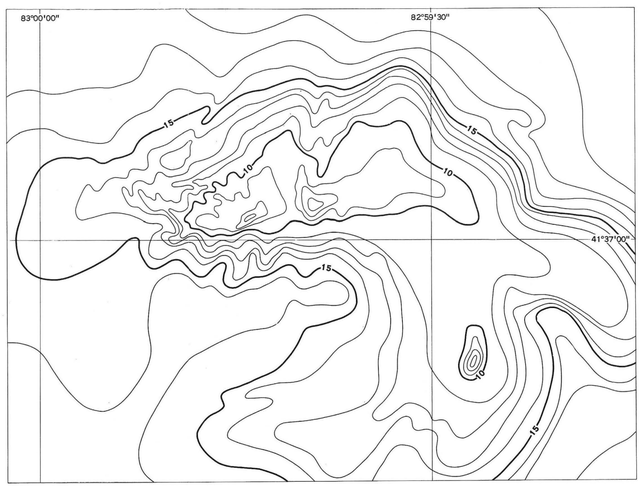
CRIB REEF



WEST REEF



LOCUST POINT REEF

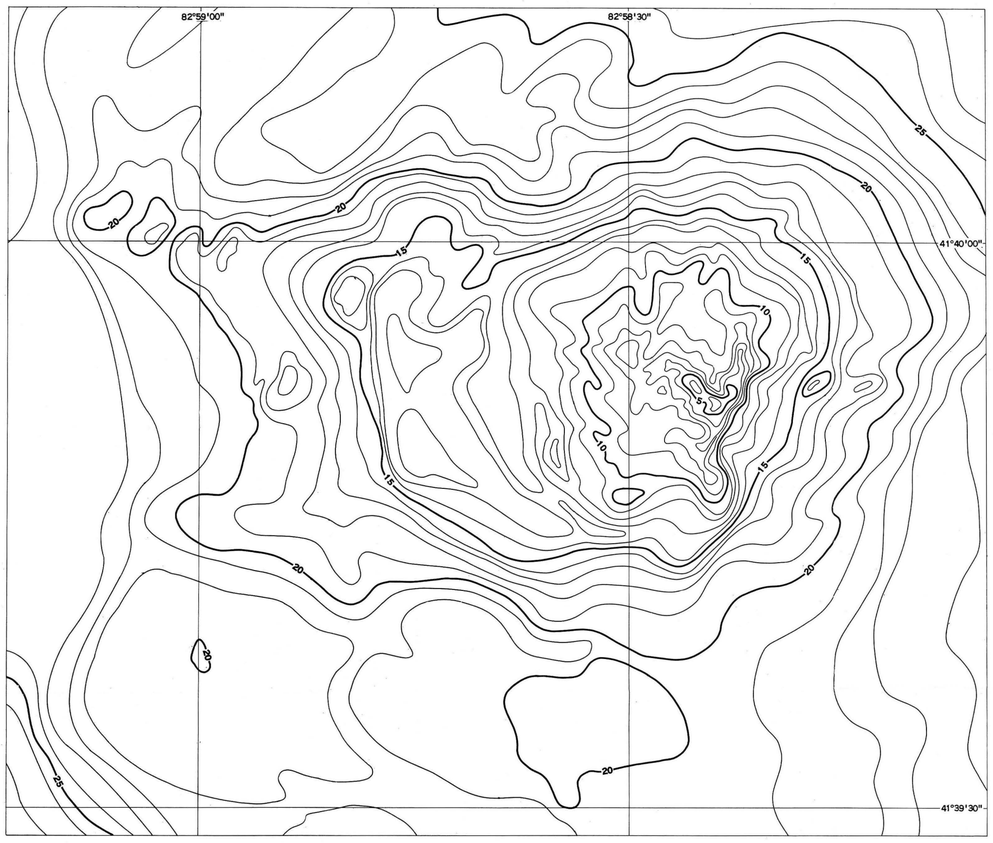


ROUND REEF

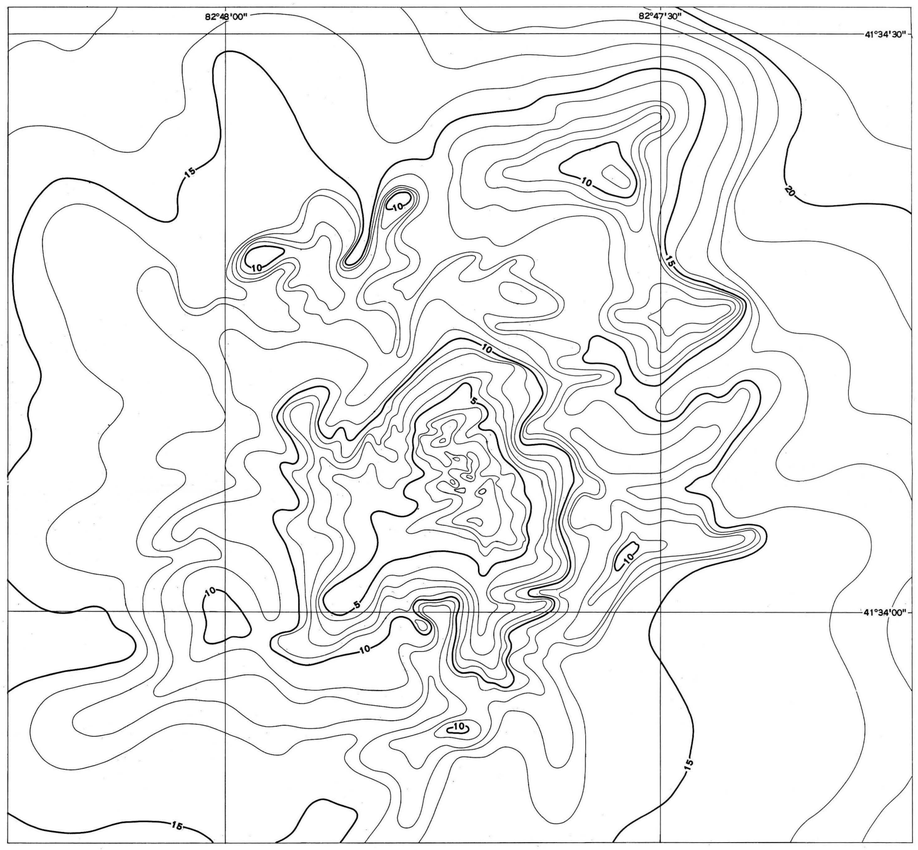
800 400 0 400 800 1200 1600 FEET

CONTOUR INTERVAL 1 FOOT
(FEET BELOW LOW WATER DATUM)

PLATE 3 (SHEET 1 OF 3). BATHYMETRY OF REEFS IN WESTERN LAKE ERIE

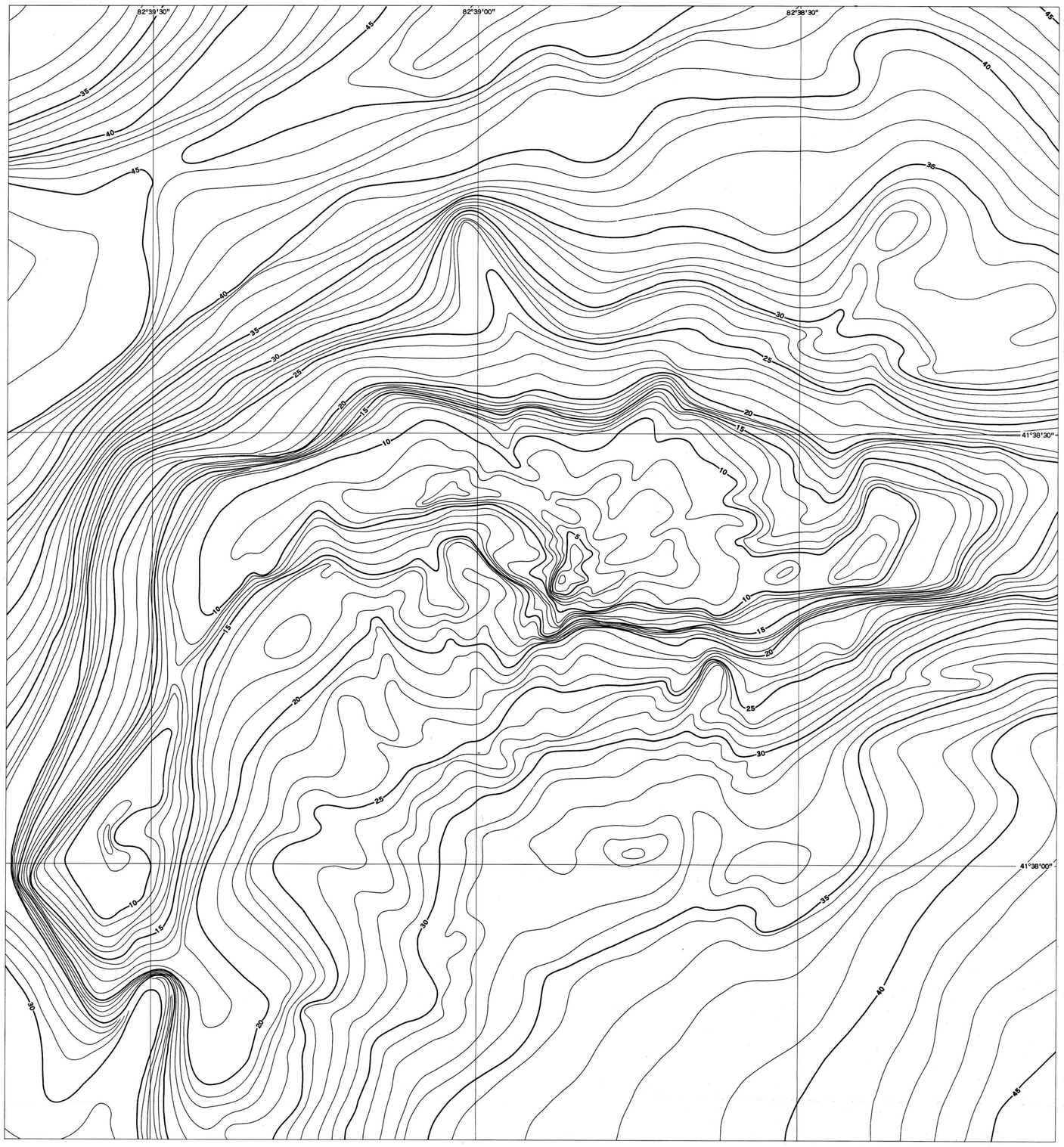


NIAGARA REEF

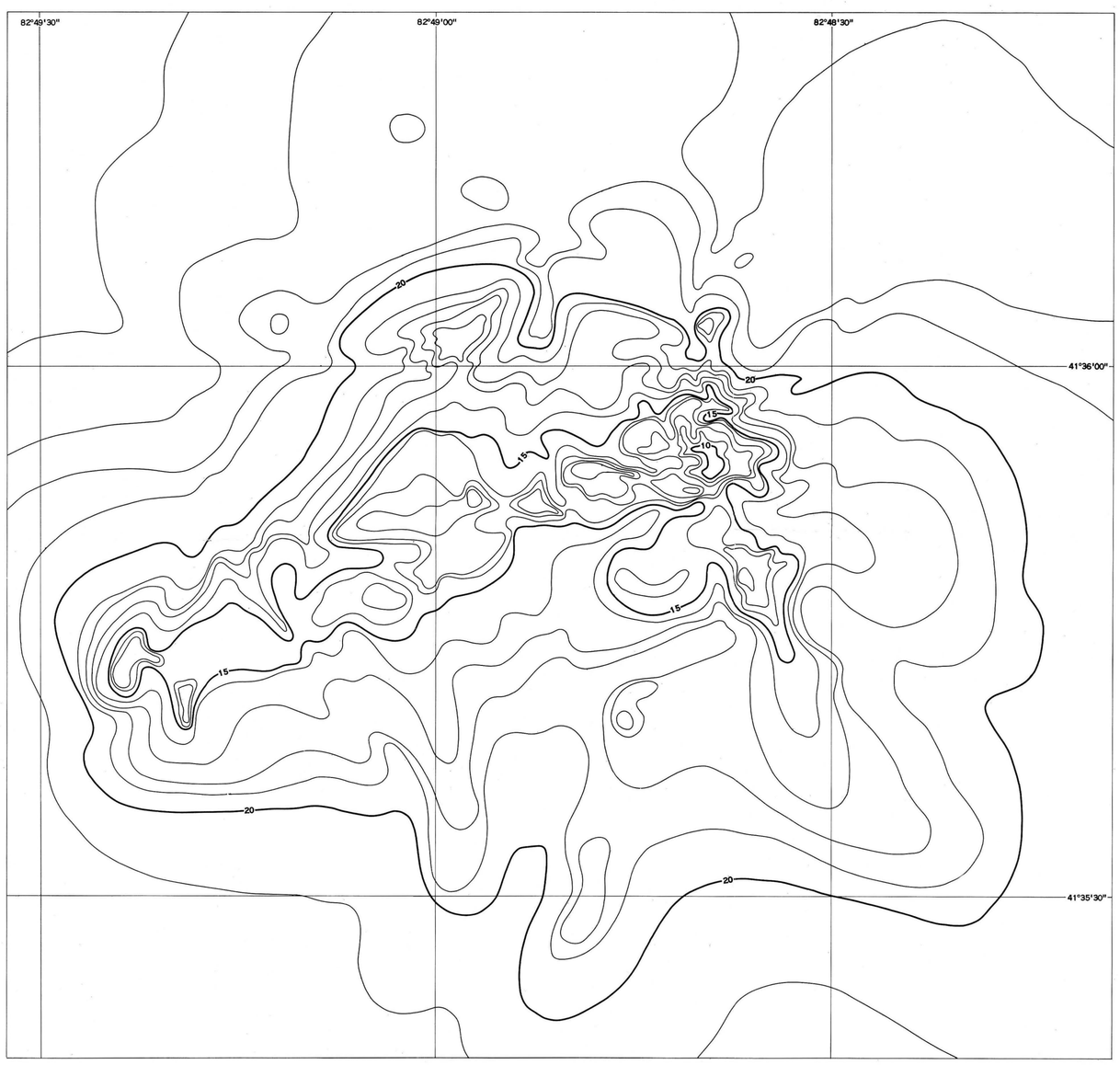


MIDDLE HARBOR REEF

TOUSSAINT REEF



KELLEYS ISLAND SHOAL



SCOTT POINT SHOAL

800 400 0 400 800 1200 1600 FEET

CONTOUR INTERVAL 1 FOOT
(FEET BELOW LOW WATER DATUM)

PLATE 3 (SHEET 2 OF 3). BATHYMETRY OF REEFS IN WESTERN LAKE ERIE

82°49'15"
82°49'00"
82°48'45"
41°37'00"
41°36'45"

STARVE ISLAND DEEP

STARVE ISLAND REEF

200 100 0 100 200 300 400 FEET

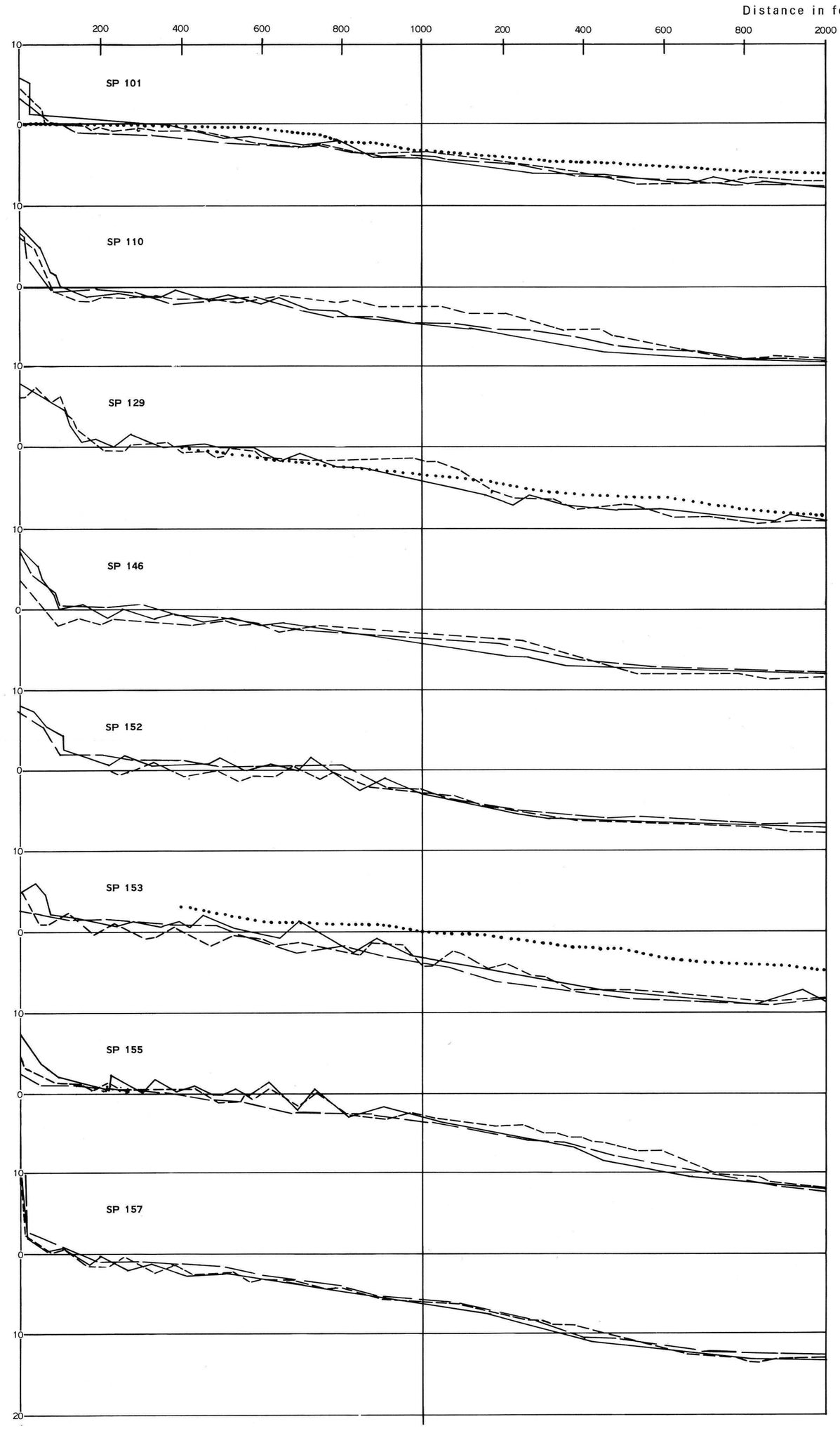
CONTOUR INTERVAL 1 FOOT
(FEET BELOW LOW WATER-DATUM)

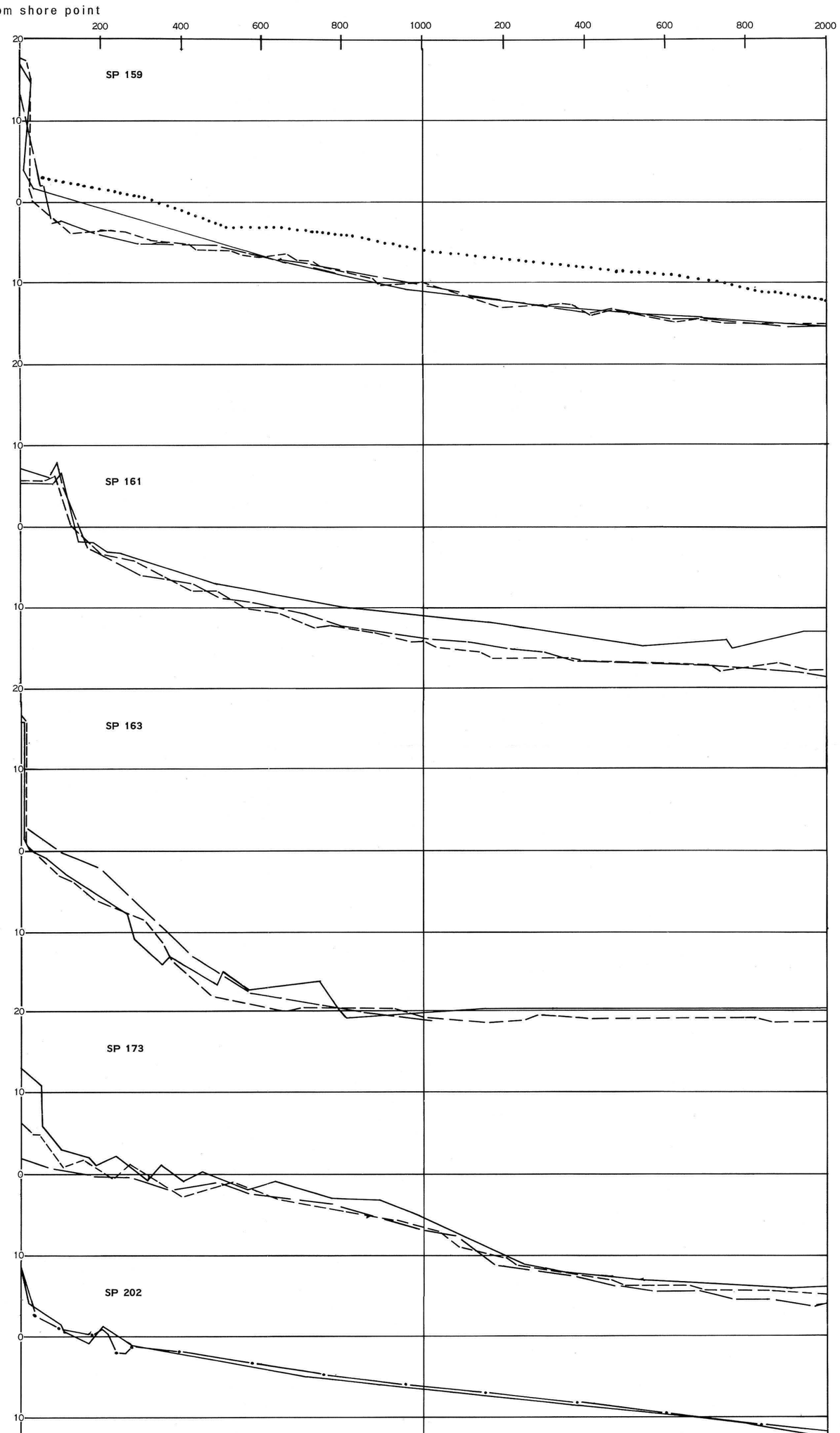
STARVE ISLAND REEF AND STARVE ISLAND DEEP

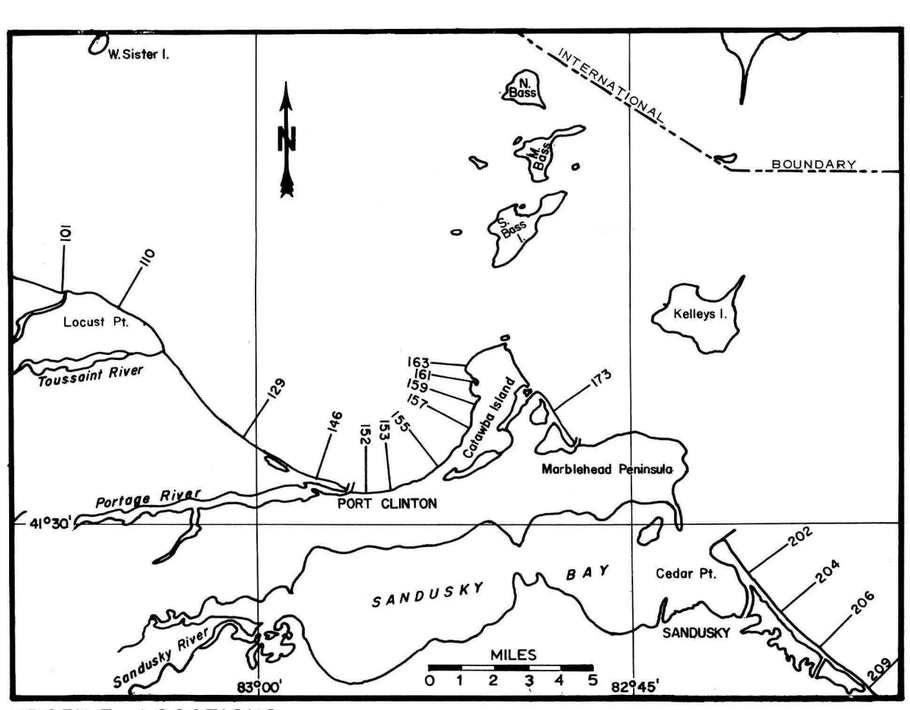
PLATE 3 (SHEET 3 OF 3). BATHYMETRY OF REEFS IN WESTERN LAKE ERIE

Distance in feet from shore point

Elevations in feet referred to Low Water Datum







PROFILE LOCATIONS

PROFILES MADE 1969 ————————

PROFILES MADE 1961 ——•——•——

PROFILES MADE 1956 —— ——

PROFILES MADE 1943 — — — —

PROFILES MADE 1877 ••••••••••••

PLATE 4. COMPARATIVE SHORE PROFILES IN THE REEF AREA OF WESTERN LAKE ERIE

Pelee Island

N. Bass I.

Middle Bass I.

South Bass I.

Kelleys Island

Locust Point

Turtle Creek

Toussaint River

Rushaw Creek

CAMP PERRY

Lacarpe Creek

Portage River

PORT CLINTON

Catawba Island

ROCK LEDGE

West Harbor

Middle Harbor

East Harbor

LAKESIDE

Marblehead Peninsula

SANDUSKY

SANDUSKY BAY

BEDROCK ELEVATION IN FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC, CANADA (IGLD, 1955)

INFERRED PREGLACIAL DRAINAGE

FEET
0 10,000 20,000 30,000

MILES
0 1/2 1 2 3 4 5 6 7 8

41°45′
41°40′
41°35′
41°30′
83°05′
83°00′
82°55′
82°50′
82°45′
82°40′

PLATE 5. BEDROCK ELEVATIONS IN THE REEF AREA OF WESTERN LAKE ERIE

Pelee Island
N. Bass I.
Middle Bass I.
South Bass I.
Kelleys Island
INTERNATIONAL BOUNDARY
41°45′
41°40′
41°35′
41°30′
Turtle Creek
Locust Point
Toussaint River
Rushaw Creek
CAMP PERRY
Lacarpe Creek
Portage River
PORT CLINTON
ROCK LEDGE
Catawba Island
West Harbor
Middle Harbor
East Harbor
LAKESIDE
Marblehead Peninsula
SANDUSKY BAY
SANDUSKY
DOLOMITE/LIMESTONE
SAND(>90%)
GRAVEL(>90%)
MUD(>90%)
AREAS WITH MULTIPLE SYMBOLS CONSIST OF AT LEAST 10% FOR EACH SEDIMENT TYPE SHOWN
FEET
0 10,000 20,000 30,000
MILES
0 1/2 1 2 3 4 5 6 7 8
83°05′
83°00′
82°55′
82°50′
82°45′
82°40′

PLATE 6. DISTRIBUTION OF SURFACE SEDIMENT IN THE REEF AREA OF WESTERN LAKE ERIE

Pelee Island
N. Bass I.
Middle Bass I.
South Bass I.
Kelleys Island
INTERNATIONAL
BOUNDARY
41°45′
41°40′
41°35′
41°30′
Turtle Creek
Locust Point
Toussaint River
Rushaw Creek
Lacarpe Creek
Portage River
CAMP PERRY
PORT CLINTON
ROCK LEDGE
Catawba Island
West Harbor
Middle Harbor
East Harbor
LAKESIDE
Marblehead Peninsula
SANDUSKY
SANDUSKY BAY
AREA OF NO SEDIMENT COVER
SEDIMENT THICKNESS IN FEET
CONTOUR INTERVAL 10 FEET
FEET
0 10,000 20,000 30,000
MILES
0 1/2 1 2 3 4 5 6 7 8
83°05′ 83°00′ 82°55′ 82°50′ 82°45′ 82°40′

PLATE 7. ISOPACH MAP OF UNCONSOLIDATED SEDIMENT IN THE REEF AREA OF WESTERN LAKE ERIE